A STEP-BY-STEP, ILLUSTRATED GUIDE FROM THE EXPERTS AT MAXIMUMPC

PC HOW-TO GUIDE

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+ **CHOOSE THE BEST!**

8 CPUs and 12 graphics cards tested

Volume 01 2015

"KILLING FLOOR 2'S GORE SYSTEM IS A BLOODY BALLET" - PC GAMER

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"ALL I CAN SAY IS: WOW." - TACTICAL GAMING
KILLING FLOOR 2

Graham
Barlow

WELCOME

I STILL REMEMBER THE feeling of pride I got when I booted my first homemade PC. It started flawlessly, then delivered the required number of beeps, indicating it was ready to install the cutting edge operating system of the day, which was the classic Windows XP! Things have certainly moved on a bit since those Halcyon days, although curiously, everything still seems to cost roughly the same. But the power you can wring from today's high-performance CPUs and GPUs makes the system I created back then look as glacial as a Segway on a mountain trail. We are truly living in an age of PC wonders. In fact, the sheer choice of components available to a budding PC builder can make it difficult to know where to start, and that's why we've created this special guide.

Take graphics cards, for example. There's a dazzling array of cards on the market right now, all at different price points, including two recently released high-enders from Nvidia, the GeForce GTX Titan X and its little brother, the GeForce GTX 980 Ti. To help you sort your R9s from your GTXs, we've put all the current contenders through their paces in our massive supertest starting on page 20. And we've also added in separate reviews of the two new GTX cards, because they arrived after we did our supertest.

If you're building your own PC, then CPUs are the other area where you have a bewildering range of choice and prices. Turn to page 10 for our CPU supertest, which pits all the latest chips against each other, so you can see which one reigns supreme.

If you're looking for inspiration for a new type of PC build, then check out our Build It section—we've included five different builds to give you some ideas, and show you the amazing types of PCs you can create. Of course, if you want something a bit more off-the-wall then you can take some inspiration from the cases produced by Jim Sailing at Smooth Creations. He helped us create three amazing *Minecraft* machines in the feature starting on page 40.

Of course, you can always customize Windows, too. See our How-To section, starting on page 80, for some great projects that show you how to make your PC look fantastic inside and out.

To round everything off, we've included 52 great speed tips on page 70 to help you get more out of everything you do on your PC, all without spending a dollar.

When I look back at my first build compared to the systems of today it's incredible to see how far we've come. If you want to make your own machine then now is the perfect time, because there's a world of performance PC power out there just waiting to be unlocked.

Graham Barlow is a contributing editor to Maximum PC, *and has been reinstalling, reformatting, and rebooting PCs, in an endless cycle, for over 20 years now.*

↘ submit your questions to: comments@maximumpc.com

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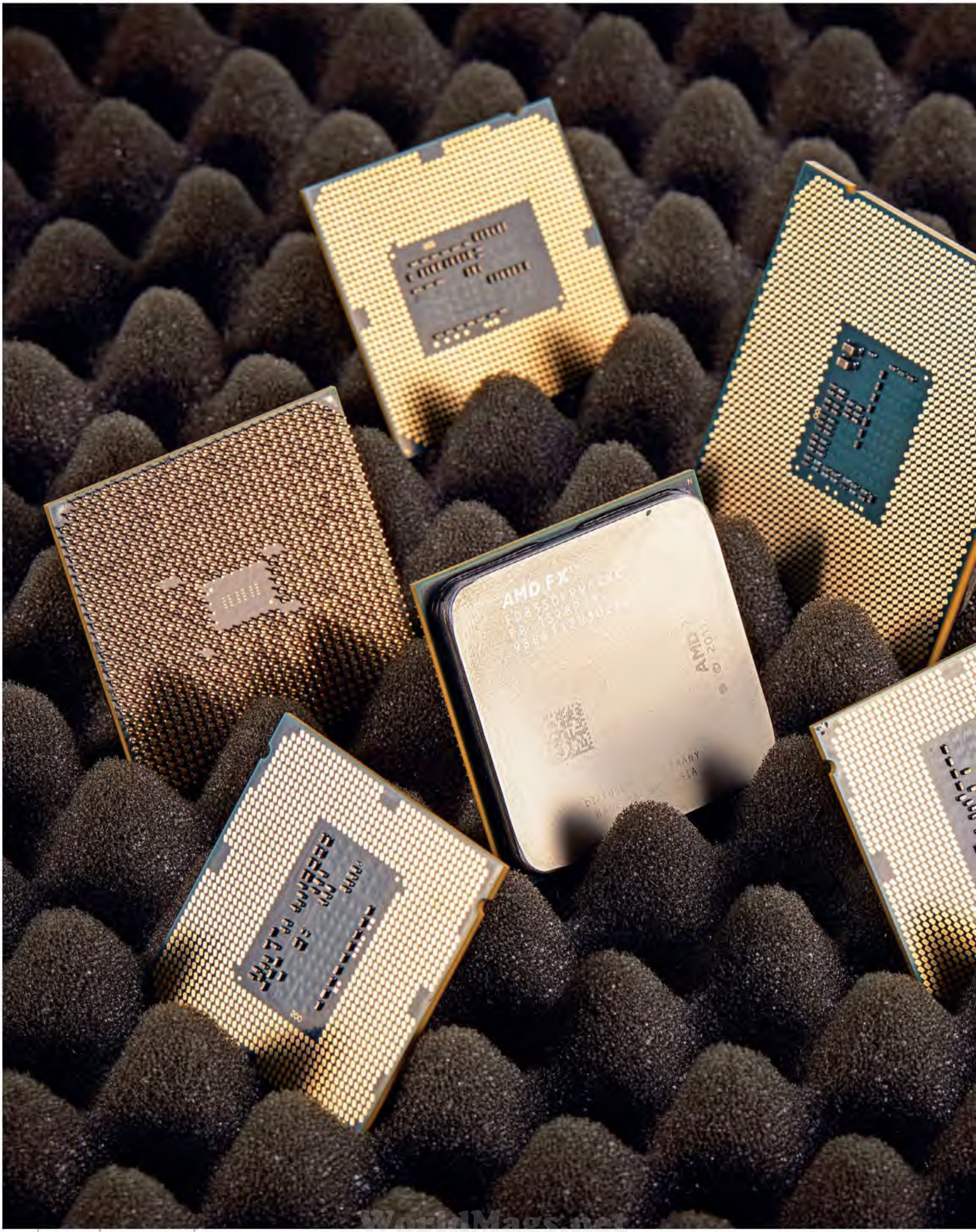
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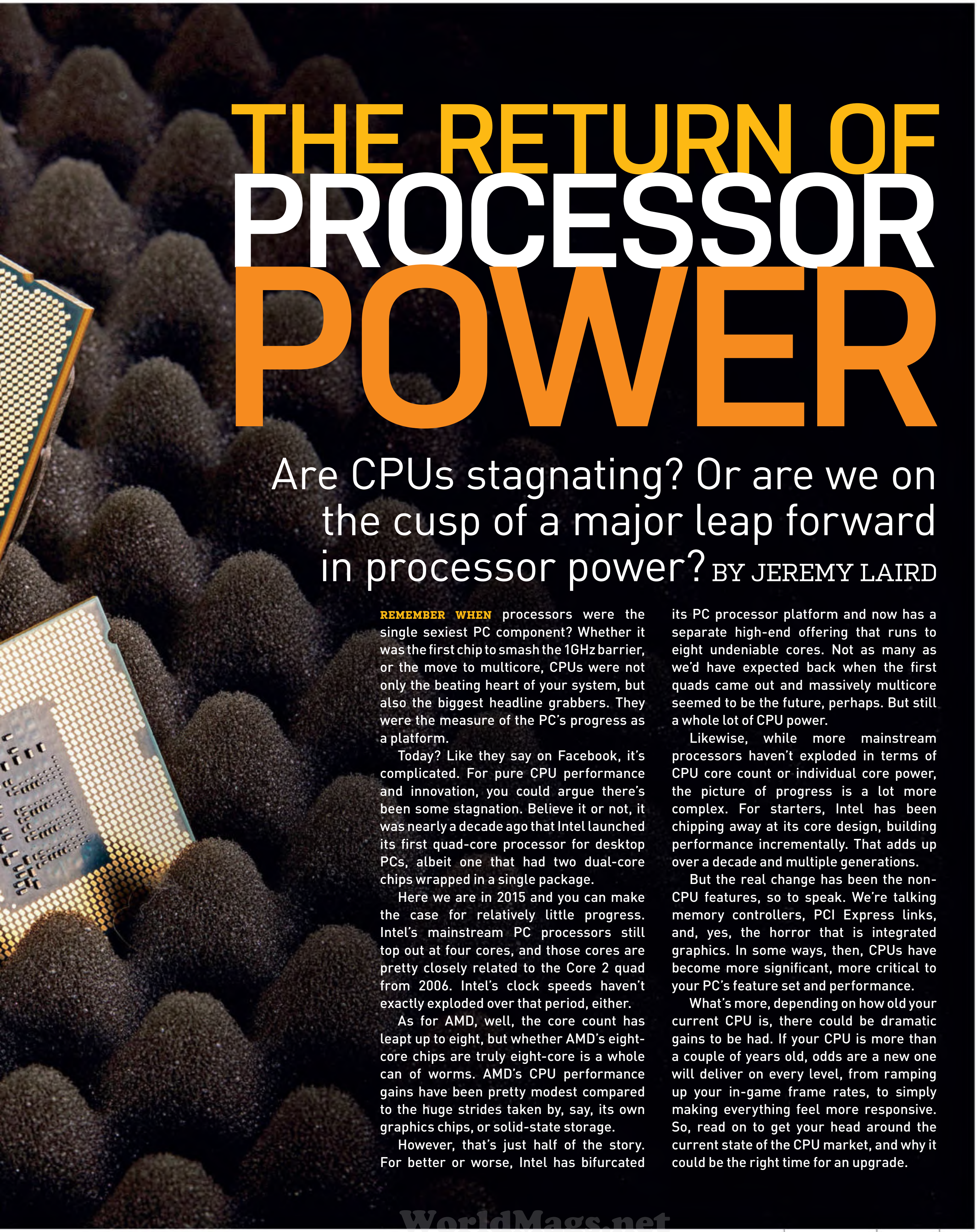


THE RETURN OF PROCESSOR POWER

Are CPUs stagnating? Or are we on the cusp of a major leap forward in processor power?

BY JEREMY LAIRD

REMEMBER WHEN processors were the single sexiest PC component? Whether it was the first chip to smash the 1GHz barrier, or the move to multicore, CPUs were not only the beating heart of your system, but also the biggest headline grabbers. They were the measure of the PC's progress as a platform.

Today? Like they say on Facebook, it's complicated. For pure CPU performance and innovation, you could argue there's been some stagnation. Believe it or not, it was nearly a decade ago that Intel launched its first quad-core processor for desktop PCs, albeit one that had two dual-core chips wrapped in a single package.

Here we are in 2015 and you can make the case for relatively little progress. Intel's mainstream PC processors still top out at four cores, and those cores are pretty closely related to the Core 2 quad from 2006. Intel's clock speeds haven't exactly exploded over that period, either.

As for AMD, well, the core count has leapt up to eight, but whether AMD's eight-core chips are truly eight-core is a whole can of worms. AMD's CPU performance gains have been pretty modest compared to the huge strides taken by, say, its own graphics chips, or solid-state storage.

However, that's just half of the story. For better or worse, Intel has bifurcated its PC processor platform and now has a separate high-end offering that runs to eight undeniable cores. Not as many as we'd have expected back when the first quads came out and massively multicore seemed to be the future, perhaps. But still a whole lot of CPU power.

Likewise, while more mainstream processors haven't exploded in terms of CPU core count or individual core power, the picture of progress is a lot more complex. For starters, Intel has been chipping away at its core design, building performance incrementally. That adds up over a decade and multiple generations.

But the real change has been the non-CPU features, so to speak. We're talking memory controllers, PCI Express links, and, yes, the horror that is integrated graphics. In some ways, then, CPUs have become more significant, more critical to your PC's feature set and performance.

What's more, depending on how old your current CPU is, there could be dramatic gains to be had. If your CPU is more than a couple of years old, odds are a new one will deliver on every level, from ramping up your in-game frame rates, to simply making everything feel more responsive. So, read on to get your head around the current state of the CPU market, and why it could be the right time for an upgrade.

Let's start with the elephant in the room, the Intel CPU architecture that dare not speak its name. Yup, it's Broadwell. And it's still not truly here, not in proper desktop format. Despite being due out last year.

What's going on? In truth, nobody outside Intel really knows. The company's move from 22nm, with Ivy Bridge and Haswell, to 14nm, with the upcoming Broadwell architecture, is at the center of everything. Intel protests that 14nm is all good. But it's perfectly obvious to everyone that bringing 14nm to market has been a major headache.

Not that we're criticizing Intel. As ever, it lives at the cutting edge of process technology. So, while it may have fallen behind its self-imposed, ambitious target of delivering a process shrink every two years, it's not like anybody else is doing better.

Intel's main rival is actually doing worse. AMD's highest-performing CPUs remain 32nm chips, albeit with manufacturing out of AMD's control since it spun off its chip-production arm. What's more, independent analysis of early mobile Broadwell parts by Chipworks has revealed Intel's 14nm tech is distinctly impressive, thanks to 13 layers and features like super-fine transistor "fins." Put simply, nobody is doing it better than Intel right now. However, distinct messiness in Intel's CPU roadmap remains.

By the time you read these words, Intel may have released a pair of Core i5 and i7-5000 series quad-core Broadwell chips for the LGA1150 socket and existing 9 Series chipset. Both sport a "C" suffix rather than the "K" indicator that Intel has been using in recent years, but are nevertheless "unlocked" chips supporting overclocking. But get this. Clock speeds are apparently lower than the top quad-core K Series Haswell models available today.

BROADWELL OR SKYLAKE?

Odd? Yup, but probably a result of the follow-up to Broadwell, known as Skylake and requiring yet another new socket, probably turning up within a few months.

But how should that influence your decision-making? The good news is that Broadwell's compatibility with the LGA1150 socket and the 9 Series chipsets, such as Z97 and H97, ensures some longevity. The bad news is that new socket for Skylake.

The thing is, if you already have an LGA1150 mobo, it's going to be fairly recent. It only appeared in mid-2013. What's more, it looks highly unlikely that Broadwell is going to be a major performance leap on the CPU side over Haswell. After all, Broadwell is technically a die shrink, not an all-new architecture. And it's not expected to do anything spectacular with regards to clock speeds. Quite the opposite.

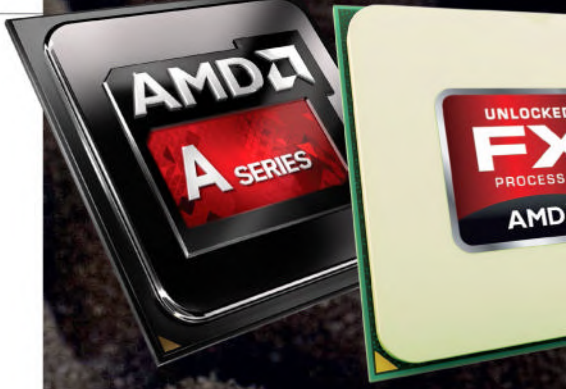
So, the case for upgrading from Haswell to Broadwell will be very marginal for most. The exception is if you went low-end with Haswell, but now have the cash for an upgrade. In that scenario, would it be worth waiting for Broadwell? Maybe. Not because we think Broadwell will be hugely compelling. But it's probably worth holding out a month or two just to be on the safe side. It's very possible that existing Haswells, like some of the models in our supertest this month, will remain the best bet.

Things get more complicated when you factor in Skylake. That's partly because Skylake's CPU performance is even more of an unknown quantity. It's also because Intel has revealed some interesting info regarding the Skylake platform. It will require the new LGA1151, which is a pain, but we're convinced there are good technical reasons. For starters, Skylake will support DDR4 system memory, which means more memory bandwidth. That's unlikely to dramatically boost performance, but it's never bad to support the latest tech.

Of greater potential consequence is support for more PCIe lanes and the new 100 Series chipsets that will come with it. In the past, PCIe lane count hasn't been hugely critical outside of systems running multiple graphics cards. But PC storage is in transition from the clunky SATA interface to quicker, solid-state optimized PCI Express interfaces including M.2. Haswell and Broadwell chips on the LGA1150 socket have only 16 lanes. On paper, a performance graphics card wants all 16. You can't just pinch a single lane from the graphics—take even one for your SSD and the card will drop all the way to eight lanes.

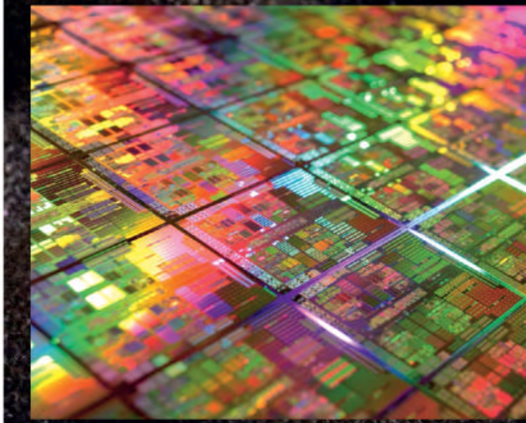
Anyway, it's possible that handing over lanes to an SSD could impact graphics performance. But Skylake and the 100 Series chipset deliver 20 lanes, giving you four spare lanes for fast storage. Hurrah. In truth, it's not actually clear how critical all of this will be. We don't think it will truly be a factor for several years, but it's clear enough that if you want to be absolutely sure of avoiding performance compromises, you need to wait for Skylake.

Unless, of course, you're willing to invest in Intel's existing high-end platform and the LGA2011v3 socket. Even the entry-level Haswell-E processor for LGA2011, the Core i7-5820K, packs a healthy 28 lanes. As for the AMD options, well, there's no denying AMD desktop platforms are falling behind in both features and performance. But they can still make sense as value propositions. To find out a little more, catch our guide to AMD's upcoming CPUs, opposite, and then flick on to our reviews of six of the best available CPUs from both Intel and AMD, for a great overview of your current options.



AMD APUs can make for a good budget box.

AMD's FX chips are still made on 32nm production tech.

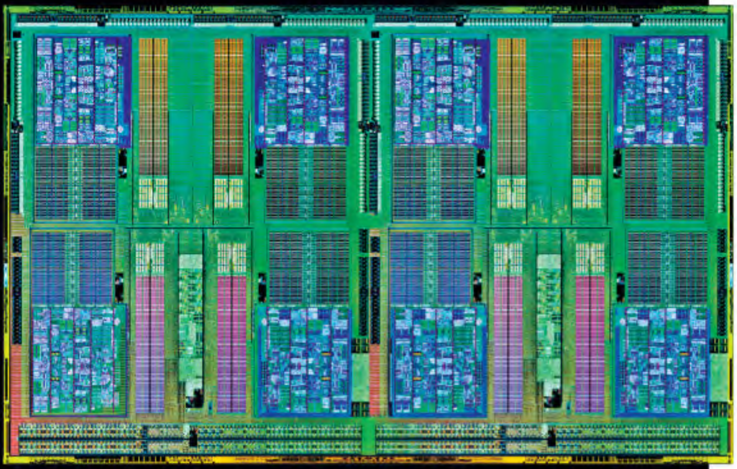


What's going on with Intel's desktop Broadwell CPUs? We wish we knew.

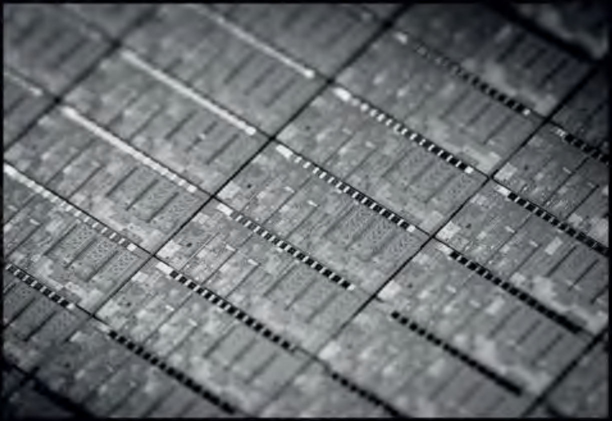
intel
Core™ i7
R3
intel
X99

> “CPUs have become more critical to your PC's performance.

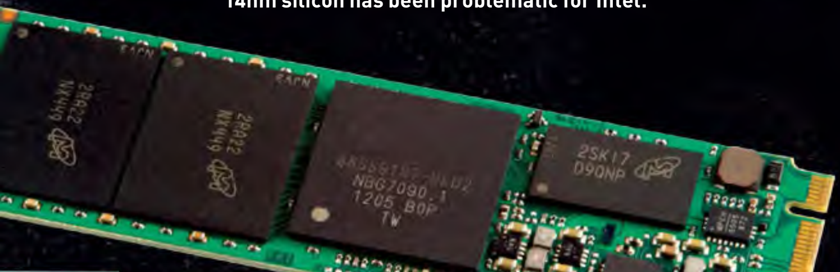
Intel's LGA1150 socket lives on, but only just.



Bye-bye Bulldozer? AMD's all-new Zen CPU is due next year.



14nm silicon has been problematic for Intel.



Intel's X99 platform and the 5820K chip are where it's at for serious performance.

If you want lots of PCIe lanes today, you'll have to pay up for Intel's pricey LGA2011v3 platform.

PCI Express-based SSDs could clash with performance graphics cards.

AMD's Bold New Plan

ZEN ARCHITECTURE IS SET TO CHALLENGE INTEL DOMINANCE

Keeping track of AMD's plans is never easy. But here's the good news. The latest update provided by AMD for investors makes for seriously sexy reading for PC enthusiasts. It's exactly what we wanted to see.

In short, it's all about a brand-new CPU architecture called Zen. It looks like everything else either dies or is on hold until Zen is out of the door in 2016. That's good because Zen is a new high-performance x86 core that AMD says addresses all the shortcomings of its existing Bulldozer-based CPU designs.

Out goes the Bulldozer's modular makeup with shared floating point units for each pair of integer execution resources. In comes something that looks a lot like an Intel CPU. That means traditional cores with not only much better capacity for IPC, or instructions processed per clock, but also simultaneous multithreading that's a dead ringer for Intel's Hyper-Threading.

Oh, and the whole thing will be built on 14nm process tech and it's due next year. And get this. AMD is claiming IPC improvements in the order of 40 percent. If AMD delivers all that, we're going to be giddy, because it'll mean Intel will finally have some serious competition. That will be excellent for everything from driving down prices to pushing up performance all-around.

Overall, AMD's latest update was a shift back toward the stuff we care about the most, namely traditional high-performance x86 processors. The company hasn't entirely ditched plans for its K12 ARM CPUs. But they've been deprioritized until Zen is on the market and won't now appear until 2017.

A huge question over the execution of these plans remains, of course. The launch of the existing Bulldozer series of CPUs wasn't the company's highest point to date, as it arrived late and failed to live up to expectations. We're therefore hopeful, but not making assumptions. Bring on 2016 and bring on Zen.

AMD A10-7850K

The future is fusion. But not yet...

Budget performance, without a budget price tag to match.

FUSION CHIPS ARE COMING. So everyone keeps telling us. And you know what? They are undeniably right. The thing is, what happens in the future doesn't help up in the here and now. It isn't much use if what's predicted for the future arrives too late to be relevant before the PC processor you buy today spirals off into obsolescence.

That's the fundamental problem for chips such as AMD's A10-7850K. In many ways, its CPU-GPU fusion of traditional processor with graphics functionality is a glimpse of how all PCs will be one day. It's how both of the latest games consoles from Sony and Microsoft already are, and, it can hardly be denied, how most of Intel's mainstream CPUs are now built. Every Intel CPU for the LGA1150 socket has integrated graphics, whether you like it or not.

But that doesn't mean it's actually good news from the end-user perspective, especially if you remotely care about gaming. The problem is that integrated graphics, even the very best currently available, still isn't great for gaming. And the 7850K has integrated graphics about as good as it currently gets.

The specs are pretty impressive. The 7850K's graphics subsystem has 512 so-called compute cores. They're not just any old compute cores either, they're GCN-spec cores, and thus essentially the same as AMD's top graphics cards and indeed the latest games consoles. In fact, the Microsoft Xbox One has 768 GCN cores in its graphics subsystem, which makes for an intriguing comparison.

Problem is, the Xbox also has a high-speed memory system to feed those cores, while the 7850K shares a standard dual-channel DDR3 memory controller between its four CPU cores and those 512 GCN cores. The upshot is that buying the 7850K as a single-chip gaming solution isn't a goer. It lacks sufficient graphics performance for serious gaming on its own.

Where things arguably get more interesting is if you pair it with a cheap graphics card in dual-GPU mode, combining the power of the integrated graphics with that low-end add-in board. On paper, it's quite a proposition. In practice, you're still talking about modest gaming performance, but now you've added the vagaries and reliability concerns of a dual-GPU rendering solution. In short, it's not for us.

GOING SOLO

All of which means the 7850K has to make a decent case for itself simply as a CPU. That's not exactly a given, especially when you consider that this "budget" chip actually costs over $130. As a straight CPU, it even loses out to the dual-core Pentium chip in some tests. Basically, anything that majors on single-threaded performance looks a little ugly. But then, you can say that about any AMD CPU right now. Indeed, as a CPU to pair with a powerful graphics card, it doesn't make much sense. Hook it up with, say, a GeForce GTX 780, and it will still drag your minimum frame rate in *Total War: Rome II* down to 27 frames per second. Yuck.

Admittedly, it's better at multithreaded tasks like video encoding than the cheap Pentium chip. But it should be at roughly twice the price. What's more, because it's manufactured on a bulk 28nm production process rather than performance-orientated silicon, the overclocking headroom isn't all that great. Its 4.4GHz max overclock is the lowest frequency here.

So, as a CPU for a proper desktop PC, it's a struggle to recommend the 7850K. As the basis of a home-theater PC with a tiny bit of light gaming on the side, it just about stacks up. But that's quite a narrow niche you have to conjure up to allow the 7850K a realistic remit. Once AMD has sorted the memory bandwidth issue for its fusion-style processors, things will get interesting. Until then, they lack appeal as budget options for gamers and enthusiasts.

VERDICT
6

AMD A10-7850K

⊞ **FUSION POWER** Lots of technology in a single chip; AMD GCN integrated graphics; decent stock clock speed.

⊟ **NUCLEAR WASTE** CPU performance is mediocre; integrated graphics isn't great for gaming; it's not quite cheap enough.

$134, www.amd.com

SPECIFICATIONS

CPU Cores/Threads	4/4
Process Technology	28nm
Clock Speed	3.7GHz, 4GHz Turbo
CPU Architecture	Kaveri
Socket	FM2+

AMD FX™
FD8350FRW8KHK
DIFFUSED IN GERMANY
MADE IN MALAYSIA
AMD © 2011 AMD

A good all-rounder, despite single-threaded struggles.

AMD FX-8350

Loads of cores. For not a lot of money

FOR ENTHUSIASTS, and especially gamers, it's tempting to think AMD's FX CPUs have become irrelevant. Knocking together an argument to that effect doesn't exactly demand mental gymnastics of Olympic quality, either. The argument would start with the fact that the Bulldozer architecture underpinning AMD's FX processors has basically been a failure. Even AMD is now tacitly conceding that, if you listen to what it's saying about its upcoming Zen processors, which are designed explicitly to address Bulldozer's shortcomings.

Even if Bulldozer had been a hit at launch, development since has been glacial. FX chips are still built on ancient 32nm silicon, while Intel CPUs are moving to 14nm. Making matters worse, AMD has let its desktop platforms and chipsets stagnate, too. Features like native support for USB 3.0 and PCIe storage? Forget it.

So, it's not hard to see why conventional wisdom says that if you're serious about your CPU, bag yourself something with an Intel badge. But conventional wisdom can get a bit smelly if you don't occasionally kick it out of bed. So, let's take the AMD FX-8350 with as open a mind as possible.

The FX-8350 is based on AMD's Vishera architecture. That means it's a 32nm chip with eight cores. Well, eight AMD-style cores, so four modules, each with a pair of integer execution units and a shared floating point unit. The idea is a slightly more hardware-intensive take on multithreading, compared to Intel's Hyper-Threading. Think of it as a halfway house between a four-core Intel chip with Hyper-Threading and a full-on eight-core chip.

Anyway, you get 8MB of level-two cache memory, plus another 8MB of level-three cache. The whole deal is clocked up at a healthy-sounding 4GHz baseclock with a small Turbo boost to 4.2GHz. Oh, and thanks to those slightly elderly 32nm transistors, it's a fairly power-hungry chip with an official 125W rating. Finally, it drops into AMD's long-standing AM3+ socket and pairs with DDR3 memory, which certainly gives a decent range of compatibility with current and quite a few legacy motherboards.

POWER PLAYER

As for performance, it really is a tale of two halves. Anything that's heavy on multithreading makes the 8350 look good. It's got the measure of the Intel Core i5-4690K, for instance, in both Cinebench R15 rendering and x264 HD video encoding.

However, shift the focus to more mixed workloads or, God forbid, something truly single-threaded, and the picture becomes patchy. In the Cinebench single-threaded rendering test, for instance, it's not even half as fast as Intel's i7-4790K.

But the picture in games isn't actually all that bad. A minimum frame rate of 36 in *Total War: Rome II* is just two behind the hallowed 4690K, for instance. That said, it's 10 frames per second behind the 4690K for average frame rate in *Rome*. You could also throw recording your game session in the background into the mix, which is something the thread-happy 8350 is much better at than the simply four-core Intel chip. Then again, your graphics card might be able to help speed that process up and make the comparison moot.

To underline that the 8350 is based on an architecture on its last legs, the backdrop is overall platform power consumption that far outstrips all the Intels, even the six-core i7-5820K beast and its complex server-derived platform, complete with quad-channel memory and more PCIe lanes than you can shake a broken SATA drive at.

So, the 8350 is probably better than you might have imagined as a gaming chip, and certainly looks good as an all-rounder, if video encoding performance is a big part of your computing mix. What it isn't, however, is a no-brainer as a CPU for a dedicated gaming box. And that's just fine.

VERDICT
8

AMD FX-8350

➕ **JUST CORES** Great multithreaded performance; tolerable gaming grunt; competitive price tag.

➖ **HOPELESS CORES** Very power hungry; AMD's chipsets are ancient; hardly a purist gaming CPU.

$166, www.amd.com

SPECIFICATIONS

CPU Cores/Threads	8/8
Process Technology	32nm
Clock Speed	4GHz, 4.2GHz Turbo
CPU Architecture	Vishera
Socket	AM3+

It's the king. At least until multithreaded gaming truly arrives.

INTEL CORE i5-4690K

Still the ultimate gaming CPU?

ALL THE GAMING CPU you'll ever need. That's the familiar refrain for Intel's quad-core Core i5 processors in unlocked K-series trim. The inference is that frills such as Intel's Hyper-Threading tech, which allows a single Intel processor core to crunch two software threads simultaneously in parallel, rather than sequentially in series, are irrelevant for PC gamers. The same applies to having a truck-load of cores. Six and eight-core chips sound impressive. But they won't run your games any faster. That's the sales pitch for the quad-core Intel Core i5-4690K. But is it actually true?

First, let's tick off the 4690K's basic speeds and feeds. It's a 22nm chip based on Intel's Haswell architecture, which means it's as advanced as it gets for desktop PC processors today. Those four aforementioned cores run at 3.5GHz, with a Turbo boost function up to 3.9GHz. As a "K" series CPU, the multiplier is also unlocked, allowing simple overclocking. And, as one of Intel's Devil's Canyon pairing, along with the Core i7-4790K, it gets improved thermal materials for better heat management compared to other desktop CPUs from the Haswell generation. As it happens, in our overclocking tests, the 4690K hits the same 4.7GHz as the 4790K. Nice.

More importantly, in our gaming benchmarks this month, the 4690K also runs the 4790K very close. The worst-case scenario is the minimum frame rate in *Total War: Rome II*, where the 4790K registers 43fps to the 4690K's 38fps. In *Battlefield 4*, there's literally nothing in it for minimum frame rates and even the averages are only separated by 3fps.

Actually, on that note, even Intel's six-core Core i7-5820K is essentially no faster in our game benchmarks. Even the mega-money Core i7-5960X Extreme and its eight mighty cores wouldn't be much faster in most games. That's the key to the 4690K's appeal. It's a giant killer at a relatively modest price.

Of course, if you broaden your computing remit, the 4690K is a less compelling proposition. Without Hyper-Threading support, it's at a clear disadvantage in applications like 3D image rendering and video encoding. The 4790K, for instance, is over 25 percent quicker when coding HD video in the x264 codec. Ouch.

FUTURE-PROOF?

Confidently, then, we can say the 4690K is a killer gaming CPU today. What's less certain is the outlook for the future. For the better part of a decade, the PC gaming industry has been promising that the future is multithreaded games. To date, that prediction hasn't entirely materialized.

Yes, games that scale to more than one CPU core are now the norm. But more than four CPU cores? That's still unusual. In that context, the 4690K is surely all the CPU you need for the vast majority of games today.

But here's the thing. There's actually good reason to think that could change dramatically in the next few years. Firstly, that's because the latest generation of games consoles from Microsoft and Sony have unambiguously thrown in their lot with multithreaded gaming. Both are based on essentially the same eight-core AMD CPU that offers fairly feeble single-threaded performance, and only makes sense if games are properly multithreaded.

Apart from the fact that a lot of PC games are straight ports from consoles, for better or worse, console games tend to set the broader game development scene. Just as important, the next version of Microsoft's multimedia API for the PC, DirectX 12, is going big on multithreading optimizations for games. It's due out with Windows 10 later this year.

All of which makes us a tiny bit unsure about recommending the 4690K for the long haul. For the next 18 months, it's an easy choice. How much longer after that it will continue to look good is a tougher call.

VERDICT 9

Intel Core i5-4690K

⊞ **PC GAMER** Awesome gaming performance; tolerably affordable; runs relatively cool and quiet.

⊟ **PC LAMER** Games might be going multithreaded; not the best all-rounder; Intel's Broadwell is coming soon.

$225, www.intel.com

SPECIFICATIONS

CPU Cores/Threads	4/4
Process Technology	22nm
Clock Speed	3.5GHz, 3.9GHz Turbo
CPU Architecture	Haswell
Socket	LGA1150

A meaty chip, but we'd stick with the 4690K or pay up for the 5820K.

INTEL CORE i7-4790K

Intel's devilish quad-core all-rounder

NORMALLY, buying the most expensive version of any CPU is for chumps. It means having your wallet hammered in return for a spec bump that's more about scoring a PR win, than actually improving your end-user experience. Should you therefore be doubly wary of the Intel Core i7-4790K? After all, it's just the top chip for Intel's LGA1150 socket. It's a stopgap replacement for what was once the range-topping quad-core Intel Haswell CPU, the 4770K.

In fact, perhaps the only reason the 4790K even exists is because the 14nm Broadwell CPU architecture is running late in desktop format, and Intel wheeled it out for the sake of simply having something new to sell. Is it the ultimate PR processor?

That's not entirely fair. The 4790K isn't simply the same old Haswell quad-core chip taken from a better speed bin and running at slightly higher clocks. There's more to the 4790K, and its so-called Devil's Canyon sibling, the 4690K, than that.

The big news is an upgraded thermal interface material, or TIM. The TIM is a thermal material, which connects the CPU silicon with the metal heat spreader that forms the top of the CPU package, and interfaces with whatever cooler you're using. Arguably, the 4790K only benefits from an improved TIM because Intel had cheaped-out on the TIM for mainstream Haswell processor models. Plus, some argue it's increased spacing between the silicon and heat spreader, not the TIM, that's been the problem with Intel CPUs of late.

Either way, for the two Devil's Canyon chips, Intel upgraded the TIM and in turn bumped up the clock speeds pretty dramatically. Where the older 4770K was clocked nominally at 3.5GHz and 3.9GHz Turbo, the 4790K rocks in at 4GHz and 4.4GHz, respectively. By any metric, 500MHz is a healthy boost.

The consequence is a quad-core, eight-thread CPU that looks pretty fast in almost any test. At stock clock speeds, it's enough to make you wonder whether you really need that six-core 5820K CPU. After all, is the broader investment required for the upscale LGA2011v3 platform worth it to increase your video encoding grunt from 53 frames per second to 62?

What's more, at these clocks and with the Haswell architecture, single-threaded performance is simply monstrous. In fact, this Intel chip is about twice as fast in the Cinebench single-threaded test as the AMD processors in the lab this month. Not that they're directly competitive CPUs. But it does give you a flavor of the task AMD faces with its new Zen CPU architecture next year. AMD could take a big step forward and still be a fair way behind Intel.

PRICE PREMIUM

Still, if there's a disappointment with the 4790K, it involves overclocking. The difficult thing with overclocking, of course, is that it varies from chip to chip. You can't simply apply sweeping generalizations. For the record, our test chip tops out at 4.7GHz. But based on the 4790K chips we've seen ourselves, along with reports around the web, that seems fairly typical.

That's both a little disappointing in absolute terms, versus the standard factory clock speeds, and not dramatically better than the 4.6GHz we're used to seeing from the 4770K. So much for that upgraded TIM.

However, our main objection remains pricing, which, if anything, has crept up in retail reality recently. The top end of Intel's mainstream platform has always felt expensive. At over $320, the 4790K is no exception. As things stand right now, its appeal as a primarily gaming CPU, compared to the 4690K, is marginal at best.

If gaming is what you're all about, forget about the 4790K. If you've a broader remit, the 4790K makes more sense. But we'd suggest you spend a bit more and step up to the LGA2011v3 platform and the 5820K.

VERDICT 7

Intel Core i7-4790K

THE ONE RING Awesome at almost everything; even quicker when overclocked; improved thermal management.

ONION RING A little short on PCI Express lanes; seriously pricey for an Intel LGA1150 CPU.

$325, www.intel.com

SPECIFICATIONS

CPU Cores/Threads	4/8
Process Technology	22nm
Clock Speed	4GHz, 4.4GHz Turbo
CPU Architecture	Haswell
Socket	LGA1150

INTEL CORE i7-5820K
SR20S 3.30GHZ
COSTA RICA
3429A709
R3

An upgrade to the LGA2011v3 socket is now very tempting.

INTEL CORE i7-5820K

Hexa-core honey you can almost afford

IS BIFURCATION NECESSARILY BAD? That sounds like a keynote speech at a dreary business conference. But it's actually been a critical question for performance PC lovers since Intel split its desktop processors into two distinct platforms way back in 2008.

Specifically, it means Intel has been running two mutually incompatible processor sockets, one for high-end desktop PCs, another for everything else. On the upside, creating a true high-end platform means Intel can inject features that just wouldn't be feasible in cost terms if present in every PC. On the other, it creates an impenetrable barrier in the upgrade path. No longer could you drop in every Intel CPU from poverty spec to bleeding edge into a single socket. Now you'd need at least a new CPU, new motherboard, and likely new system memory, too. Ouch.

What's more, for much of the time, the performance jump from the best of Intel's mainstream chips to the bottom rung of its high-end platform hasn't been spectacular, despite coming at a painful price. What's more, a closer look at Intel's high-end platform has always left the uneasy impression of being thinly disguised server hardware, complete with features that are fairly redundant for the desktop.

That's the conflicted context for the i7-5820K. It's compatible only with Intel's high-end platform, which today means the LGA2011v3 socket and the X99 chipset. With its quad-channel DDR4 memory subsystem, the sense of server-system bandwidth overkill remains. But the 5820K might just be the most appealing chip yet for one of Intel's modern high-end platforms.

Partly, that comes down to pricing. At almost $400, it's not cheap. But it's not *that* much more expensive than the top chip for the LGA1150 socket, namely the i7-4790K. OK, you have to factor things like mobo and memory into the equation. But odds are, whatever CPU you buy, you'll need a new mobo to go with it. You might be able to limit the overall price premium of going with Intel's high-end platform to around $100.

Interesting, but what does it buy you? In the case of the 5820K, the most obvious upside is an extra pair of CPU cores, so six cores in total. Plus, thanks to the delay in bringing the Broadwell family to market, both chips sport Haswell-style CPU cores, where previously Intel's high-end platform has tended to run a generation behind.

EXPRESS DELIVERY

Of course, the 4790K's cores are clocked higher at 4GHz nominal and 4.4GHz Turbo, versus 3.3GHz and 3.6GHz for the 5820K. But both chips are fully unlocked. In our overclocking tests, the 4790K tops out at 4.7GHz, with the 5820K only a little behind at 4.45GHz. That 250MHz difference represents roughly a 5 percent frequency disadvantage, hardly a huge penalty to pay for 50 percent more cores.

Even running at standard clocks, the 5820K inevitably hammers its quad-core sibling in heavily multithreaded software like image rendering and video encoding. Factor in overclocking and it's no contest.

You might expect good old games to turn the tables. Indeed, the 4690K is generally a bit quicker in games. But the advantage is hardly dramatic. Moreover, if it's a pure gaming CPU you seek, it's actually the 4690K and its simpler quad-core design and lack of Hyper-Threading support that makes for the uncomfortable comparison and the better bet, not the 4790K.

However, as an all-rounder, the 5820K is seriously appealing. That's especially true when you factor in its advantage in terms of extra PCI Express lane availability over any Intel CPU sitting in the LGA1150 socket. As SSDs move to PCIe interfaces, it could make the difference between running everything at full speed and having to make some tricky compromises.

VERDICT 8

Intel Core i7-5820K

⊞ **SPELLBINDING** Six of Intel's finest CPU cores; epic multithreading performance; best platform features in the business.

⊟ **CURSE ON YOU** Overall platform cost is painful; ordinary single-threaded performance; needs to be overclocked to give its best.

$375, www.intel.com

SPECIFICATIONS

CPU Cores/Threads	6/12
Process Technology	22nm
Clock Speed	3.3GHz, 3.6GHz Turbo
CPU Architecture	Haswell-E
Socket	LGA2011v3

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Fancy some 4.6GHz old-school overclocking action for $70?

INTEL PENTIUM K ANNIVERSARY G3258

A reminder of when clock speed was king

REMEMBER THE GOOD OL' DAYS when Intel, and AMD for that matter, really only made one CPU? Sure, you could still choose from a whole hill of processor models, from bargain basement to punitively overpriced, but underneath it all, it was just one chip from each outfit.

Back then, CPUs were all about clock speeds. Higher frequencies meant more performance and more money. OK, you might have found the odd feature was fused off. But clock speed was king. The fun bit involved buying a dirt-cheap model and clocking it to Hell and back. The result was often a high performance CPU for a pittance. But not these days.

There are two reasons for that. Firstly, variable core counts tend to spoil the fun. Intel, for instance, offers everything from dual-core right up to eight-core chips. In each case, that's all you get. There are no hidden cores to be re-enabled. The other problem is that the whole overclocking thing has been locked down tighter than a drug baron in a supermax prison. All the old-school fun involving bus speeds and dividers is ancient history. Your only realistic option is via the CPU multiplier. And that's only unlocked for a limited range of Intel processors.

It's all pretty miserable compared to the swashbuckling, frequency-free-for-all days of yore. At least it was until Intel unexpectedly remembered it had a whole army of keen PC enthusiasts ready and waiting to celebrate a bit of low-budget fun.

Enter the G3258, a one-off special designed to recall those heady early days when you could overclock almost anything.

In this case, we're dealing with a dual-core version of the same Haswell architecture found in every other Intel CPU here, including the super-flash six-core Core i7-5820K. So, it's bang up-to-date in architectural terms.

But, it's also conspicuously light on features. There's no Hyper-Threading. You don't get a Turbo mode. It just runs at 3.2GHz. You have to make do with 3MB of cache memory. However, as the "K" suggests, it is fully unlocked. So you can clock it as high as you dare, or at least as high as the silicon can cope with.

GIANT KILLER?

In the case of our test chip, that's a very creditable 4.6GHz. In other words, it'll run at roughly the same clock speed as the much more expensive Intel chips here. But, because it normally runs at a modest clock speed, 4.6GHz means an epic 1.4GHz overclock. And all for $70. Impressive, as they used to say in *Quake III*, back when giant-killing CPUs were the norm.

That said, the huge overclock is just as well, because the G3258's performance at its standard 3.2GHz clock speed is patchy. The budget gaming thing looks dicey when you see it delivering just under half the frame rate of a quad-core i5-4690K. Scary.

Moreover, even that huge 1.4GHz overclock only represents a 40-something percent overclock, while you'd need a full 100 percent to match the 4690K at stock clocks. So, yes. If you base a gaming rig on this special Anniversary chip, you're going to suffer lower frame rates, even if you clock it to the absolute max.

Of course, at this price point, there's only so much you can expect. The same goes for a CPU that supports just two software threads. We may not have entered the boldly multicore age of computing that was predicted a decade ago. But a desktop PC with just two cores and no per-core multithreading is still seriously old news. There's a limit to what you can expect.

However, clocked beyond 4GHz, the G3258 is great value and lots of fun. If you're on a budget or looking for a stopgap, then it makes sense. It's not a giant killer in the traditional sense, but that's because those days are almost certainly gone.

VERDICT
7

Intel Pentium K Anniversary G3258

+ PRINCE AMONG PROCESSORS
Dirt cheap; sports Intel's Haswell cores; overclocks like a trooper.

− PROCESSOR FORMERLY KNOWN AS...
Weedy performance at stock clocks; only two cores; short on features.

$70, www.intel.com

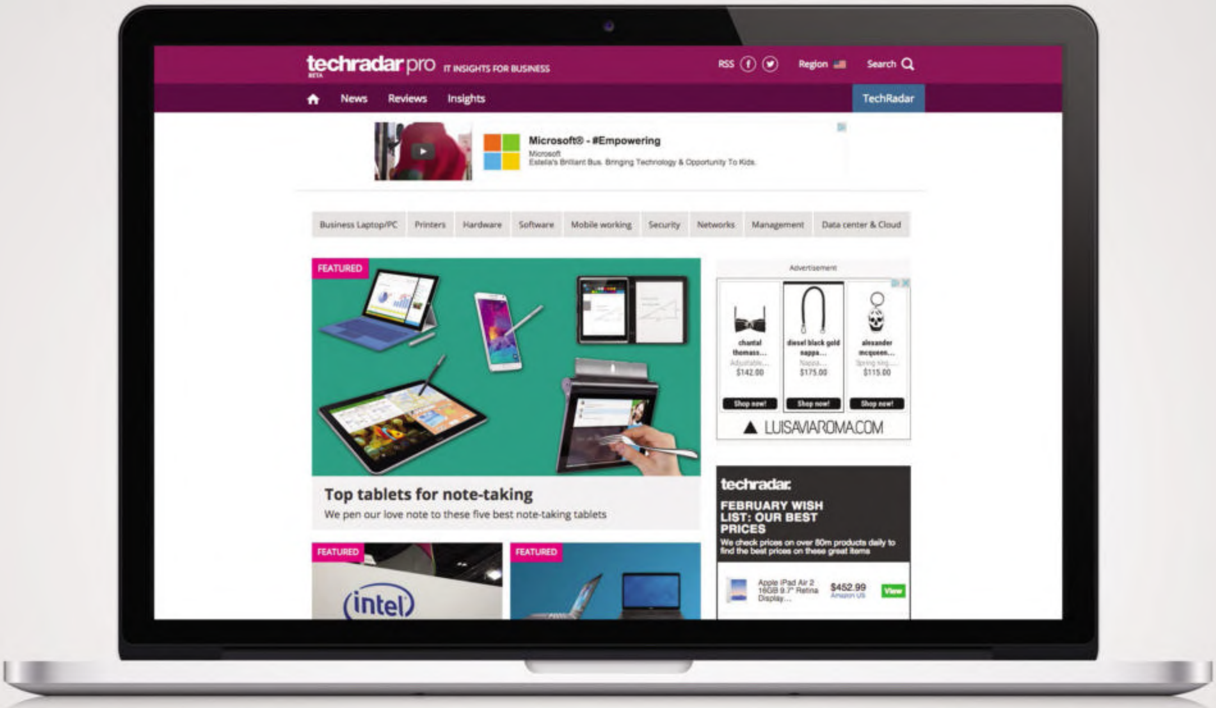
SPECIFICATIONS

CPU Cores/Threads	2/2
Process Technology	22nm
Clock Speed	3.2GHz
CPU Architecture	Haswell
Socket	LGA1150

Future

techradar.pro

IT INSIGHTS FOR BUSINESS



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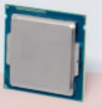
BENCHMARKS

	AMD A10-7850K	AMD FX-8350	Intel Core i5-4690K	Intel Core i7-4790K	Intel Core i7-5820K	Intel Pentium K Anniversary G3258
Cinebench R15 (Single)	91	88	150	173	140	117
Cinebench R15 (Multithread)	311	570	586	880	1,006	235
X264 v4.0	24.2	43.9	40.1	53.3	61.5	16.9
Sandra bandwidth (GB/s)	14.3	15.8	17.7	17.7	41.5	17.8
TW: Rome II (min/avg fps)	27/46	36/54	38/64	43/67	38/66	34/53
Battlefield 4 (min/avg fps)	37/51	54/79	59/91	59/94	59/96	31/45
Peak Power (W)	131	218	122	195	175	83
Max OC (GHz)	4.4	4.6	4.7	4.7	4.4	4.6
Cinebench R15 Max OC	356	645	686	927	1,299	326
Power Max OC (W)	182	272	176	218	305	129

Overall winner is highlighted. The gaming benchmarks are run at their highest settings, with 4x AA running at 1080p. All chips tested with 8GB of RAM, except the Core i7-5820K, which was tested with 16GB, and Nvidia GeForce GTX 780 Ti.



SPECIFICATIONS

	AMD A10-7850K	AMD FX-8350	Intel Core i5-4690K	Intel Core i7-4790K	Intel Core i7-5820K	Intel Pentium K Anniversary G3258
Website	www.amd.com	www.amd.com	www.intel.com	www.intel.com	www.intel.com	www.intel.com
Price	$134	$166	$225	$325	$375	$70
CPU Cores/Threads	4/4	8/8	4/4	4/8	6/12	2/2
Process Technology	28nm	32nm	22nm	22nm	22nm	22nm
Clock Speed	3.7GHz, 4GHz Turbo	4GHz, 4.2GHz Turbo	3.5GHz, 3.9GHz Turbo	4GHz, 4.4GHz Turbo	3.3GHz, 3.6GHz Turbo	3.2GHz
CPU Architecture	Kaveri	Vishera	Haswell	Haswell	Haswell-E	Haswell
Socket	FM2+	AM3+	LGA1150	LGA1150	LGA2011v3	LGA1150
Score	6	8	9	7	8	7

And the winner is...

INTEL CORE i5-4690K

CONFIDENTLY, then, we can say the Core i5-4690K is a killer gaming CPU today. What's less certain is the outlook for the future. For the better part of a decade, the PC gaming industry has been promising multithreaded games. To date, that prediction hasn't entirely materialized.

If these six CPU models represent the current state of the PC processor market, what have we learned? For starters, it's a little disappointing to note that prices have crept up a little on a few of the Intel chips.

Inevitably, component pricing fluctuates. But the idea that you have to pay more for what are relatively elderly CPUs is tough to stomach. That said, it reflects the fact that we can no longer assume that computer chips are just going to always get faster and cheaper. Intel's difficulties bringing 14nm desktop chips to market, along with AMD's FX processors being stuck on 32nm technology, are testament to that.

INTEGRATED OR DISCREET?

The next problem involves integrated graphics. It's not something we discussed much in our reviews of Intel's CPUs. That's because Intel's patchy drivers and inadequate performance means integrated graphics remains irrelevant in the context of even remotely serious PC gaming. That applies to AMD's best integrated graphics, too, which uses up-to-date AMD GCN graphics tech. It's not truly gameable.

Discreet graphics is therefore the way to go, and, for the long term, that makes us just a little uneasy about every CPU here, save for the Intel Core i7-5820K. How so? Because of possible future conflicts between graphics and SSDs over PCIe bandwidth. It may turn out to be a non-issue. But it's a pity that we'll have to wait for Skylake later this year for a mainstream Intel processor with more than 16 PCI Express lanes piped into the CPU socket.

That said, perhaps the surprise package of this test is AMD's FX-8350. There's no denying the single-threaded shortcomings of its CPU core design. Nothing will change that until AMD's new Zen CPU arrives next year. In the meantime, the FX-8350 may be a little off Intel's pace in games, but in-game performance is certainly acceptable, especially if you overclock. Factor in strong multithreaded performance and the FX-8350 looks like a strong overall proposition. If only AMD's chipsets and platforms didn't look so old and crusty.

As for the AMD A10-7850K, we're less impressed. Like we said, the integrated graphics bit isn't really much use and the 7850K's dual-module, pseudo quad-core CPU is neither great for gaming, nor a multithreading beast.

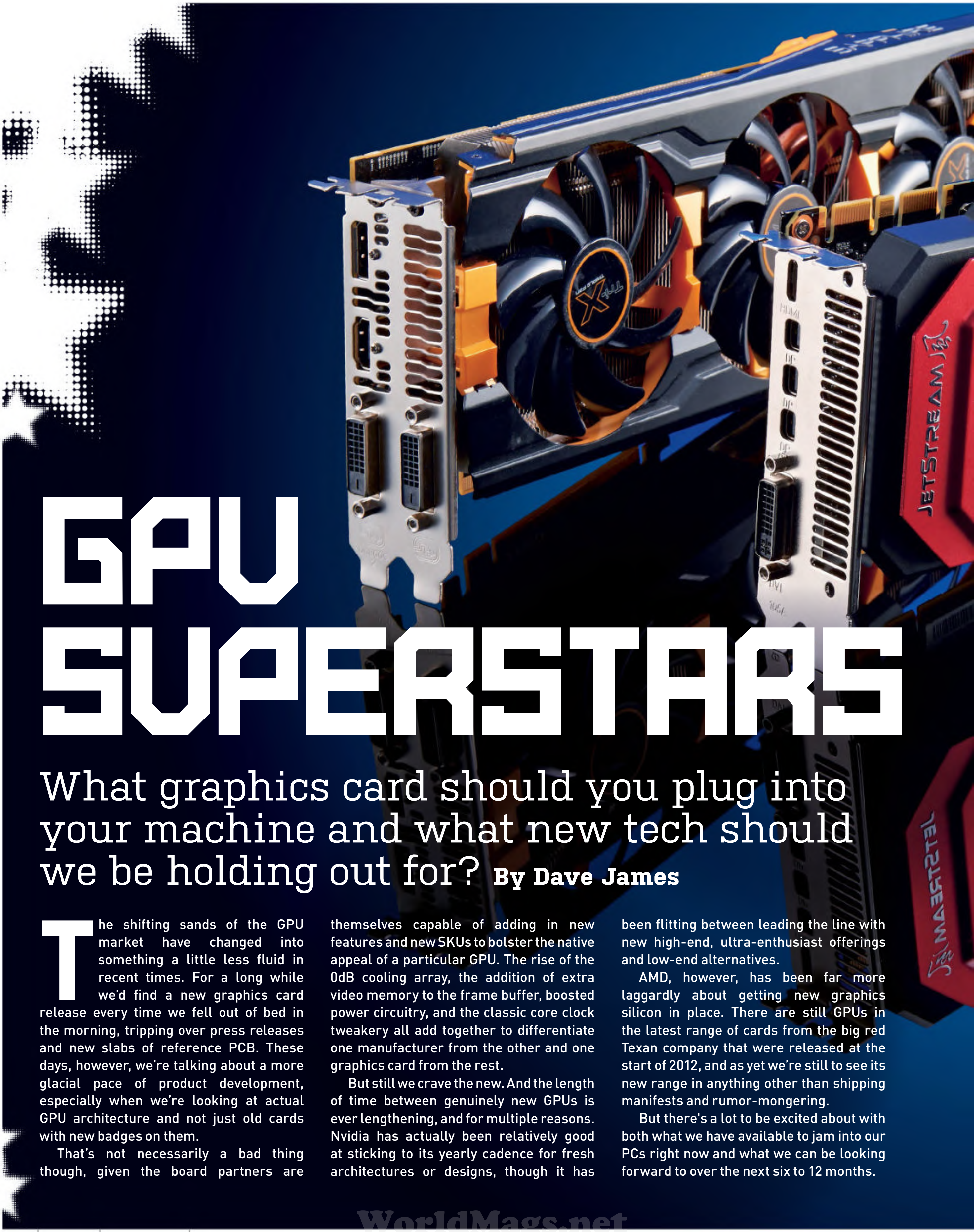
Of our Intel quartet, the Pentium K Anniversary is a lot of fun, but only if you're committed to overclocking. At stock clocks, its gaming performance is poor. Next for the chop is the Core i7-4790K. In many ways, it's the best all-rounder here. But it's also expensive, and in terms of gaming at least, the benefits of its Hyper-Threading tech aren't all that compelling.

MONEY TALKS

Instead, if we wanted a chip with proper beefy multithreading performance, we'd actually prefer to pay even more and do the job justice with the six-core Core i7-5820K. It's a serious bit of hardware, especially when you factor in the advantages of the high-end X99 platform. As much as any CPU can be, it's an upgrade that looks a great long-term investment.

All of which means the i5-4690K remains the CPU of choice for gaming purists. It's not the absolute fastest gaming CPU you can buy, according to the benchmarks. However, we doubt any other CPU would deliver noticeably better gaming performance in the terms that really matter. And if you can't feel it, why pay for it?

> **It's a pity that we'll have to wait for Skylake for a mainstream Intel processor with more than 16 PCI Express lanes piped into the CPU socket.**



GPU SUPERSTARS

What graphics card should you plug into your machine and what new tech should we be holding out for?

By Dave James

The shifting sands of the GPU market have changed into something a little less fluid in recent times. For a long while we'd find a new graphics card release every time we fell out of bed in the morning, tripping over press releases and new slabs of reference PCB. These days, however, we're talking about a more glacial pace of product development, especially when we're looking at actual GPU architecture and not just old cards with new badges on them.

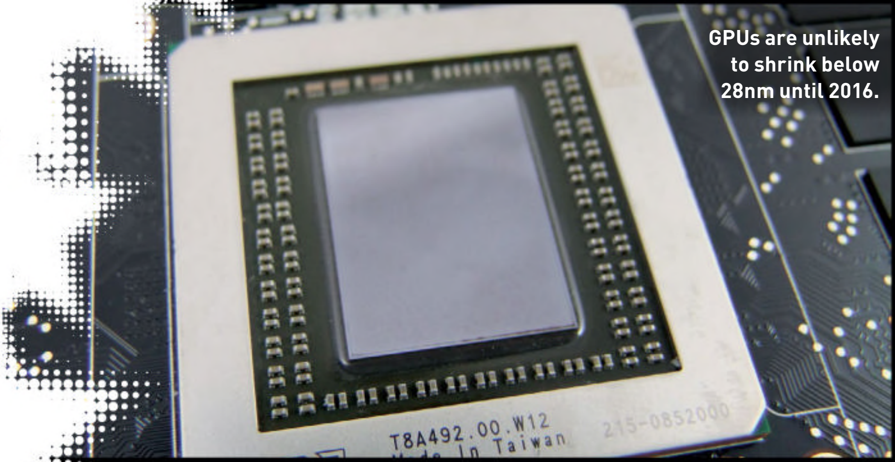
That's not necessarily a bad thing though, given the board partners are themselves capable of adding in new features and new SKUs to bolster the native appeal of a particular GPU. The rise of the 0dB cooling array, the addition of extra video memory to the frame buffer, boosted power circuitry, and the classic core clock tweakery all add together to differentiate one manufacturer from the other and one graphics card from the rest.

But still we crave the new. And the length of time between genuinely new GPUs is ever lengthening, and for multiple reasons. Nvidia has actually been relatively good at sticking to its yearly cadence for fresh architectures or designs, though it has been flitting between leading the line with new high-end, ultra-enthusiast offerings and low-end alternatives.

AMD, however, has been far more laggardly about getting new graphics silicon in place. There are still GPUs in the latest range of cards from the big red Texan company that were released at the start of 2012, and as yet we're still to see its new range in anything other than shipping manifests and rumor-mongering.

But there's a lot to be excited about with both what we have available to jam into our PCs right now and what we can be looking forward to over the next six to 12 months.

IceQ X²
HIS
GEFORCE GTX 980



GPUs are unlikely to shrink below 28nm until 2016.

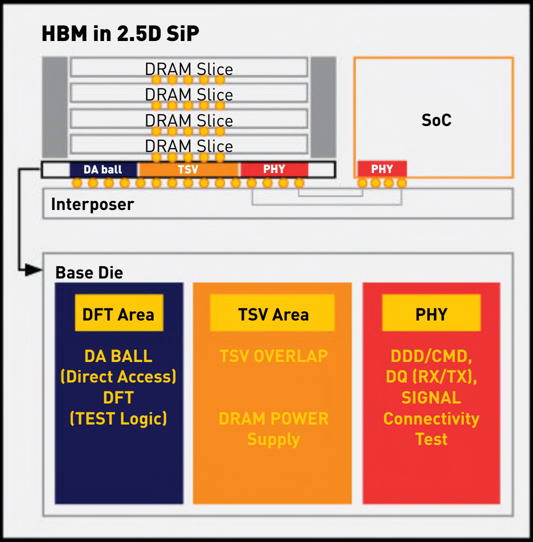
Graphics cards used to be almost immune to the creeping mobile disease that had been holding back the central processing unit. Where the CPU was starting to be designed with a mobile-first strategy in mind—being beefed up slightly to make for a decent desktop offering, sacrificing raw processing grunt for power-efficient functionality—the GPU was always this enormous chip with little-to-no thought given to the power needed to get the damn thing running or the heat that it was continually producing.

Graphics cards got bigger as the silicon bloated. Single slot options all but vanished. And the power and cooling demands got ever more outlandish and, eventually, became mostly unsustainable.

Over the last few generations though, the marketing money has increasingly gone into educating us all about the performance per watt improvements that successive GPU architectures have achieved.

Thankfully, the processor guys have suffered all the trials of the search for performance efficiency so that our graphics cards don't have to. That means we're still getting improved GPU performance, generation-on-generation, but we are also seeing power draw and temperatures continue to drop.

AMD's Fiji will be the first GPU with High-Bandwidth Memory (HBM).



Nvidia has been the one leading the charge here in the PC sector. First with the Kepler architecture improving on the hot mess the top-end Fermi cards had become, and then with its current marvelous Maxwell architecture. The latest design has been set up so that it can scale from the very small all the way up to the professional class super-computer chips.

RED DAWN?

So what has AMD been doing? Not a lot. Just take its latest top-end GPU, the Hawaii chip released in the dying light of 2013. It's probably a coincidence it was code-named after a volcanic island, but the super-heated, massive GPU ran at a frankly crazy 93 C under load with the reference cooling design from AMD. And it was designed to run at that speed according to the AMD people we questioned at the time too, as our test rig started to glow white hot...

Its last new GPU, the Tonga chip in the R9 285, is the first of the Graphics Core Next raft of silicon to actually make proper strides in the pursuit of improved GPU efficiency. Dropping the TDP of the equivalent R9 280 down from 250W to 190W, it's still been able to maintain performance while drawing less power and generating less heat too.

That's still a lot higher than the TDP of Nvidia's latest top-end consumer GPU, the GTX 980, which has a thermal design point of just 165W. So, how come Nvidia has been able to make such strides before AMD and why are we still waiting on its competing graphics architecture to give Maxwell a run for its money?

You have to look back a little way to get to the bottom of this. AMD was in fact ahead of its time when, generations ago, it took the gamble of focusing on smaller GPU designs with lower power draw. It chose to cede the top-end of the graphics market to Nvidia's increasingly large and hot chips. Instead it tried to use dual-GPU designs to compete at the high-end where such efficiency concerns could be ignored.

Then it got all excited about the performance of its newer architectures, getting caught up in the battle for the biggest top-end numbers, abandoning its initial impulse, and producing ever bigger and more power-hungry GPUs once more. Nvidia, meanwhile, suddenly switched tack with the Kepler designs, and AMD was left not knowing which way to jump.

LITHE LITHOGRAPHY

Now, to really hit the efficiency figures it needs to with the existing GCN architecture AMD is intent on sticking with, the company needs to get its silicon onto a smaller, less power-hungry production process. Last year we were expecting to move down to 20nm, which would allow for smaller chips generating less heat. But problems with production, performance, yields, and the cost has made it unlikely we'll see a 20nm GPU even this year.

There's still faint hope the new Fiji GPU in the upcoming Pirate Islands range will be produced on the 20nm process, but even that might turn out to be wishful thinking. The fact we're still waiting on its release this far into 2015 suggests AMD may be committed to waiting it out. We sure hope so. The big news for the Fiji GPU though is that it's going to be the first GPU to be sporting High-Bandwidth Memory (HBM). Well, that and the fact it's expected to be rocking some 4,096 streaming microprocessors—it's going to be one sizable chip if AMD can't hit 20nm. Hell, it's going to be massive even if it can. The collaboration between Hynix and AMD though has produced a stacked version of the frame buffer, in a similar way to the V-NAND in Samsung's 850 SSDs, which will allow for a huge amount of bandwidth.

Arranged around the GPU, rather than actually on top of the graphics silicon, HBM is able to offer a significant amount of bandwidth, a massive 640GB/s in fact. That's almost double what's on offer with Nvidia's new Titan X (see page 34). At the moment the memory is arranged in four 1GB stacks, each delivering a 1,024-bit bus. That makes for an enormous, aggregated 4,096-bit bus, and implies the actual memory speed is slower than standard GDDR5, again similar in the way Samsung has used older memory tech in its V-NAND. The second-gen version of HBM is set to go even further, offering up to 8GB and 256Gb/s of bandwidth per stack.

The rest of the Rx 3xx series of graphics cards are likely to be only slightly tweaked versions of the same 28nm GCN GPUs we've got in the current lineup. The Tonga GPU looks to be getting a rebrand as the R9 370 and 370X, with the lower-end part being similar to the R9 285 and the higher-end one being the R9 285X we were expecting last year. The R9 380 and R9 380X are likely to be mildly modified versions of the Hawaii chips from the top-end cards of the previous gen, despite sporting new GPU code-names of Grenada.

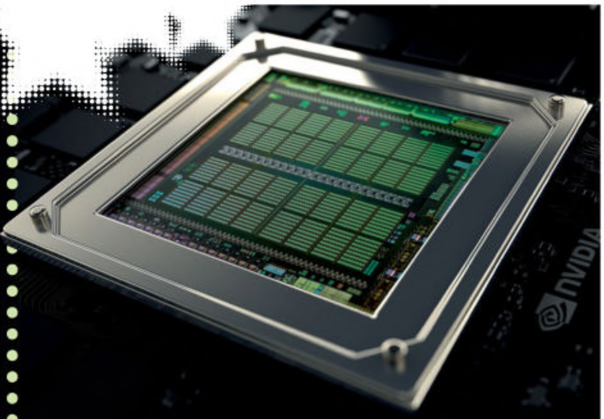
BLAISE OF GLORY

Looking further afield, Nvidia will be joining in on the stacked video memory fun in 2016 with its Pascal GPU architecture. It will feature a similar kind of memory as the R9 390X in that it's arrayed around the GPU rather than directly on top of it, but is also going to introduce a new interconnect between CPU and GPU called NVLink. The new fatter pipes are expected to deliver up to 80GB/s of data compared with the 16GB/s we've got in today's systems.

So, if that's the past and the future of our graphics cards, how do things stand today? We've brought together the current generation of GPUs in the following pages to see how the best gaming silicon of today stacks up against each other.

Nvidia CEO Jen-Hsun Huang announcing Maxwell successor Pascal.

I'm out of my mind excited about it—Jen-Hsun Huang talking about NVLink.



The Great Green Memory Conundrum

WHEN COMMUNICATIONS BETWEEN TECH MARKETING AND ENGINEERS FAIL, A GRAPHICS CARD SUFFERS

It would be remiss of us to talk graphics tech without mentioning the recent controversy surrounding Nvidia's GTX 970 GPU and its "miscommunicated" technical details. Something happened between the engineers and the technical marketing team because the launch specs of the GTX 970 came out all kinds of wrong.

Originally we were told the basic configuration of the GM 204 GPUs in both the GTX 970 and GTX 980 only differed in terms of the CUDA core count, with them having the same 104 texture units, 64 ROPs, 2MB L2 cache, 256-bit bus, and 4GB GDDR5 memory. Some parts of that official spec are plain wrong. Some are mightily misleading. Importantly, the GM 204 inside the GTX 970 actually only contains 56 ROPs and 1.75MB L2 cache.

That mistake is largely forgivable as it doesn't really affect the way the card performs—it was already behind the GTX 980 on that count anyway. The bigger issue is that 4GB frame buffer. It came to light that the GTX 970 was reporting only 3.5GB before tapping out in scenarios where the GTX 980 would go all the way to 4GB.

It turns out the memory systems on these two Maxwell cards are very different, something linked into those shut-off ROPs. Nvidia segmented the memory on the lower tier card into a 3.5GB chunk and an extra 512MB block, but the larger block has a full 192GB/s of theoretical bandwidth, while the smaller is running at just 28GB/s. That means if a game runs over the 3.5GB portion of frame buffer, performance will drop drastically because the access time is much slower. It's not quite as slow as when you go over 4GB on either of these Maxwell cards as it's still faster than the 16GB/s bandwidth over the PCIe connection to the system memory.

Realistically the GTX 970 hasn't been designed for the sort of high-res situations where this is typically an issue, but as more texture data is used by games, that 3.5GB portion is going to find itself exceeded. Why it's really an issue though is the fact Nvidia didn't communicate any of this until it was caught by enthusiasts testing their own cards. This doesn't suddenly make the GTX 970 a bad card, but it makes the market a bit wary moving forward.

Nvidia GeForce GTX 980

The more affordable mighty Maxwell

UNTIL THIS MONTH, Nvidia's GTX 980 was the top single-GPU graphics card around. And then the inevitable happened. The green team dropped the full force of its GM 200 Maxwell core in the form of the GTX Titan X. We've gone into detail on the new ultra-enthusiast card on page 78, but suffice to say it's the new GPU performance king.

At nearly $1,000, however, it's beyond the reach of most of our bank accounts, which is why it and the R9 295X2 aren't included in this supertest. So we're concentrating on cards you're actually likely to buy, rather than just dream about. Still, the GTX 980 is no budget option. Prices start at around $550, with some manufacturers offering versions for another $100 or more.

The GTX 980 is still one hell of a gaming graphics card though. It may not hit the same levels of 4K gaming as its Titanic big brother, but it really doesn't do badly. This card is hitting some 36fps in *Battlefield 4* at 4K Ultra, and 34fps in *Shadow of Mordor* at the same graphics settings.

But having spent a lot of time with 4K monitors, anything below 40 inches just feels too small and you're really paying a severe performance price. So we're still more than happy with our 1600p and 1440p screens, and at those resolutions, the GTX 980 is an absolute monster. Throw it on to a super-wide 34-inch 21:9 panel too, and it just flies in whatever game you throw its way.

PRICE WARS

This Maxwell card though is caught in a battle with AMD's Radeon R9 290X. Because there's been such a long time between its launch and the release of the upcoming Pirate Island, R9 3xx series, the prices of current-gen AMD stock have nose-dived like they were piloted by Harrison Ford himself. The AMD card opposite is now $200 cheaper than this impressive GTX 980, and isn't *that* far off in terms of 1080p or 1600p performance.

You can though pick up GTX 980s with funky 0dB cooling arrays, where the fans only start spinning when the GPU hits a certain temperature. It also runs with a good chunk less power than the Radeon.

We also have to talk about the Nvidia ecosystem as a whole. When it released the GTX 980, Nvidia came out with a set of interesting techniques to get either more performance or more visual fidelity from our games. Dynamic Super Resolution (DSR) allows you to run at higher resolutions than your monitor can produce by rendering at that high level and shrinking it down to fit your screen. For games with performance to burn, such as *GRID 2* in our suite of tests, that adds a little extra quality while still delivering the performance.

On the flip side, where you're struggling for speed, there's Multi Frame Anti-Aliasing (MFAA), which can produce 4x levels of antialiasing with the performance hit of only 2x. Then there's Voxel Global Illumination (VXGI), the cheating pseudo ray-tracing tech just included in the current custom branch of Unreal Engine 4.

At the current price though it's tough to look past the R9 290X bargain. In those Sapphire clothes it's cool and quiet and blazes through 1080p and 1600p benchmarks. The GTX 980 is just a little too expensive for the relatively small performance boost it offers right now.

SPECIFICATIONS

GPU	Nvidia GM 204
CUDA Cores	2,048
Memory Capacity	4GB GDDR5

VERDICT 8

Nvidia GeForce GTX 980

JETSTREAM Great gaming performance; 0dB cooler options; bulging ecosystem.

WETSTREAM Still seriously expensive.

$550, www.newegg.com

Sapphire R9 290X Tri-X

Clearing out the speedy old stock

WITHOUT A NEW GPU IN SIGHT, AMD inevitably has to fight the good fight on pricing these days. The big, powerful Hawaii XT GPU inside this R9 290X is a complex ol' graphics processor and must cost a few bucks to produce in numbers. And that's why at launch it was the same price as the GTX 980 is right now.

Some 18 months later we're gearing up for a summer launch of AMD's next generation of graphics cards—including a reworked Hawaii XT appearing with a new badge—and Nvidia has just unleashed its massive Maxwell card. With stock still in the channels, prices on older AMD cards have drastically dropped. That means this Sapphire version of the R9 290X is a stunning $350.

The first, reference edition of the 290X we tested was a roaring hot mess, delivering great gaming performance, but running at a molten 95 C when pushed in-game. Thankfully AMD has some great partners like Sapphire, who were able to turn the 290X into a card you'd actually feel safe enough to drop into your own machine. You know, without worrying it was going to spontaneously combust during an intensive round of *Peggle*.

The Tri-X chiller on this Sapphire R9 290X is fantastic, cutting that 95 C peak temp down to just 71 C—cooler than the GTX 980 with its efficient Maxwell GPU. And it's also remarkably quiet when it's working away too, those three fans never hitting the roaring blast the reference chip chiller shouted out.

GOT GAME?

Performance-wise, it's obviously behind the GTX 980. But neither card is a real 4K gaming GPU on its own anyway, so you're looking lower down the resolution scale to 1600p, 1440p, or 1080p. And at that scale the 290X delivers high enough frame rates that the performance difference between it and the GTX 980 becomes almost inconsequential. The Nvidia card does, however, offer higher minimum frame rates across the board. That means you'll be getting a smoother gaming experience with the GeForce option.

But you're going to have to pay for that privilege, and when you're looking at a good $200 more than this Sapphire 290X, that makes it a much tougher ask. If you can afford the GTX 980, that's the better card. This Sapphire's current cost, however, makes it the smarter purchase for the more price-conscious PC builder.

The R9 290X isn't the only AMD card to have seen a hefty price drop. The R9 290 is so close to the 290X that it's mighty tempting too. It's still rocking a full 4GB frame buffer and, because it's still the Hawaii GPU, it's running across an aggregated 512-bit memory bus. But given the pricing is so close, this Sapphire 290X remains the champ performance-for-price GPU right now.

Nvidia will keep shouting about the extras it offers, and with GeForce Experience offering a better... well... experience than the bought-in Raptr setup, it's tough to argue. But when we're talking value, the aging AMD cards still have a lot to give at this price. Just make your move now. When the supply in the channel runs out, those prices aren't going to last.

SPECIFICATIONS

GPU	AMD Hawaii XT
GCN Cores	2,816
Memory Capacity	4GB GDDR5

VERDICT

9

Sapphire R9 290X Tri-X

⊞ **HAWAII** Serious gaming speeds; cool and quiet; great price; hefty memory configuration.

⊟ **ALCATRAZ** Not quite as quick as the GTX 980; trades performance blows with GTX 970.

$350, www.sapphiretech.com

Gigabyte GTX 970 G1 Gaming

Much maligned, but still standing

THE POOR OL' GTX 970 has taken a pounding since the nightmare that followed its release. It seems the engineering team hadn't communicated the smart work it had done in splitting up the cache. That meant Nvidia's marketing bods got confused, thought it had basically the same GPU and memory layout as the GTX 980, and ended up misleading everyone.

And then it came out. And the Internet got all kinds of grumpy. It's a real shame. If Nvidia had communicated what it had done, we'd have been impressed it'd kept hold of essentially a 4GB frame buffer through some unprecedented tech goodness, even if it was split between a speedy 3.5GB bit and a slower 512MB part.

The performance problems only really start when you fill up that 3.5GB portion. And those are situations the GTX 970 was never really meant to get into. *Shadow of Mordor* is the only current game which tops that with its HD texture pack—it hits 5GB at 1600p Ultra settings, which would mess up any GPU except the Titans.

So don't believe the hype. The 970 is still a great card. That's especially true with this outstanding Gigabyte version. The triple fan array keeps it super chilled at just 58 C under load and the gaming performance can often push an overclocked R9 290X into second place. The AMD card though has the better memory bus, so operates quicker at high-res and at the moment is cheaper. But it's a mighty close run thing between these two quality cards.

SPECIFICATIONS

GPU	Nvidia GM 204
CUDA Cores	1,664
Memory Capacity	4GB (3.5GB & 512MB)

VERDICT 8

Gigabyte GTX 970 G1 Gaming

+ **G1** Excellent cooler; great overclocking performance; speedy gaming.

− **1D** Rage-filled memories of miscommunication.

$350, www.gigabyte.com

XFX R9 290 Black OC Edition

In a Hawaiian no-man's land

WITH THE RECENT AMD PRICE CUTS trying to shift existing stock before the new generation drops, plus take the sting out of the Titan X launch, its graphics card stack has been mightily squeezed. It's more obvious with the three R9 28x cards below this R9 290, but it's still getting tricky for the second-tier Hawaii card to make a name for itself.

The issue is the R9 290X now costs just $350. That's only around $45 more than this XFX OC Edition card, leaving the poor ol' R9 290 in a bit of a no-man's land. It's a lot more expensive than the R9 285 and can't quite catch up with its big Hawaiian brother. Granted the relative performance stats of the two Hawaii GPU-powered cards are incredibly close, but we'd still recommend spending that little extra on a definitely superior slice of silicon.

It also helps that the Sapphire card is so quiet despite the roaring, 2,816-core beast smouldering away under that cooling array. But XFX's dual-fan design is still good. The stylish-looking shroud keeps the Hawaii Pro GPU to the same 71 C maximum as the Tri-X cooler manages.

None of that really helps when there's almost no real place for this capable card right now. That might change though as availability of the cheaper R9 290X drops off as the supply line runs dry in preparation for the Hawaii GPU to get respun as the R9 380 and R9 380X. But until then we'd still recommend spending your cash on the excellent R9 290X if you're in the mood for a good value GPU upgrade.

SPECIFICATIONS

GPU	AMD Hawaii Pro
GCN Cores	2,560
Memory Capacity	4GB GDDR5

VERDICT 8

XFX R9 290 Black OC Edition

+ **SUPER COOL** Good gaming performance; sleek shroud; quality cooling.

− **PITY THE FOOL** Everything else about it.

$306, www.xfxforce.com

HIS R9 280X IceQX2

Are you still here?

THERE'S SOMETHING ODD about the R9 280X. There's also something old about it. That's the Tahiti XT GPU at its heart. This card is essentially the Radeon HD 7970 GHz Edition from three years ago. We'll let that sink in. Three years. It goes to show the slow progress AMD graphics tech has made. But also how capable its GCN architecture has been. The fact it's still decent is incredible.

But this card should've been put out to pasture, replaced by the R9 285X, with its Tonga XT GPU. And where is that card? It's maybe still stuck in engineering hell because the Tonga GPU struggled playing nice with Mantle, possibly because of its changed memory system and funky new memory compression algorithms.

So the 280X is still here and still on sale. Unfortunately the pricing on it hasn't changed to reflect the market, meaning this anomalous HIS card is priced higher than the much quicker R9 290 from XFX. And because the Tahiti GPU is old school GCN, it's missing out on the goodness of the later silicon. Most tellingly it doesn't have any support for AMD's new frame syncing technology, FreeSync.

If you're already sitting on an R9 280X, don't panic. Even though it's a 3-year-old card, its high-end memory configuration, with 3GB running over an aggregated 384-bit bus, means it's still very capable at both 1080p and 1600p. But you should look elsewhere if you're thinking of upgrading—there's no value to buying a 280X anymore.

SPECIFICATIONS

GPU	AMD Tahiti XT2
GCN Cores	2,048
Memory Capacity	3GB GDDR5

VERDICT
6

HIS R9 280X IceQX2

⊞ **XT** Well-specced GPU and memory; decent gaming performance.

⊟ **ATARI ST** Old-fashioned tech; power-hungry; lacks FreeSync support; expensive.

$280, www.hisdigital.com

Sapphire R9 285 DualX

Making the right cuts

THE R9 285 IS AMD'S MOST RECENT graphics card. Its Tonga GPU is the most modern GCN architecture around, utilizing a similar memory compression algorithm to Nvidia's latest Maxwell chips. That means AMD has got similar effective memory bandwidth levels through more conservative buses and memory configurations.

As such, the R9 285 comes with a 256-bit bus and a 2GB frame buffer compared with the R9 280's 384-bit bus and 3GB frame buffer. For the most part that doesn't make much difference. They're within a few frames per second of each other in most gaming benchmarks. They're also a similar price. But the 285 does give you access to things like AMD's TrueAudio Technology and FreeSync.

But, achieving parity in *most* of our benchmarks? Well, where they don't is telling. The 280 posts slightly improved scores playing *Battlefield 4* via DirectX 11, but is much better in our top-end *Shadow of Mordor* test. That's a benchmark that thrives on memory performance. It highlights where the newer chip and its cheaper memory subsystems are failing. The issue is that this is where game engines are heading—the R9 285 is going to struggle in the future of VRAM-intensive gaming, even at 1080p.

This Sapphire card could be in trouble. For now its $250 price tag makes it a great card, but you have to weigh up whether you need FreeSync or whether you want the ol' 280's memory setup. Tough choices.

SPECIFICATIONS

GPU	Tonga Pro
GCN Cores	1,792
Memory Capacity	2GB GDDR5

VERDICT
7

Sapphire R9 285 DualX

⊞ **TONGA** Decent current-gen gaming speed; FreeSync and TrueAudio support; great price.

⊟ **TONKA** Weaker memory setup; will quickly become dated.

$250, www.sapphiretech.com

Asus STRIX GTX 960

Cool, quiet, and ornithological

THE GTX 960 IS ALMOST IDENTICAL to the R9 285 in so many ways. They are priced similarly, they perform almost identically in our gaming benchmarks, and they both have the same memory issues.

Nvidia's GM 204 GPU saw it working with some new compression algorithms. This new technique allows it to use a small memory bus and still retain a relatively high effective memory bandwidth. The GTX 960 then has a 2GB frame buffer running across a lowly 128-bit bus, which delivers some 112GB/s of bandwidth, though with the new compression jazz in place it estimates that to transform into 149GB/s effective.

That makes sense from a manufacturing point of view—the 128-bit bus is obviously cheaper to make than that double-width 256-bit bus on the GTX 760 this card is replacing. But that doesn't help us gaming types. More titles are demanding extra frame buffer capacity to deliver the highest performance. Suddenly, adding extra gigabytes to the VRAM allocation is offering higher fps.

Again, it's *Shadow of Mordor* highlighting what's in store. Both the GTX 960 and R9 285 fall behind the geriatric R9 280 with its 384-bit bus and 3GB frame buffer. But it's still a tough choice. We wouldn't recommend anyone upgrading to a 3-year-old GPU, so the R9 280 is right out. At this price it's all down to who's cooling, ecosystem, and drivers you trust more. The STRIX is practically silent, cool, and not so thirsty, and we do so love GFE...

SPECIFICATIONS

GPU	Nvidia GM 204
CUDA Cores	1,024
Memory Capacity	2GB GDDR5

VERDICT 8

Asus STRIX GTX 960 OC Edition

⊞ **STRIX** Super-chilled; almost silent; small; good 1080p performance.

⊟ **STRUCK OUT** Weak memory system; not future-proofed.

$210, www.asus.com

Powercolor R9 280 TurboDuo

Help the aged help themselves

THE R9 280, with its ancient Tahiti Pro GPU, is like that old man you find in small town nightclubs. The girls laugh and dance with him in mocking amusement and yet he refuses to pass quietly into the night. Except in this case, the old man would be taking one of those girls home and showing her that with age comes experience...

The R9 280, like the 280X, is a 3-year-old graphics card. It was the old HD 7950, a top card of its generation, meaning it's still got a beefy memory bus and a healthy 3GB frame buffer. So, even though it's looking kinda dated—it doesn't have the latest GCN architecture's new feature set—it's still got the raw GPU horsepower and componentry to power its way to impressive gaming performance. Unlike the 280X though it has a much more reasonable price tag. It's priced $40 below the R9 285, making it a very affordable card which allows you to almost hit 60fps at 1080p Ultra settings in *Battlefield 4*. It smashes the 285 and the GTX 960 in *Shadow of Mordor*.

So, it's still a good card and this mighty affordable Powercolor version comes with a quality cooler keeping things nicely chilled and quiet. If there's one in your current rig, and you've got some PSU headroom, grabbing another for a CrossFire setup would give you great performance for a relatively minimal outlay. But if you're looking for a new single card upgrade, we still can't recommend 3-year-old hardware, especially if FreeSync is playing on your mind like it is ours.

SPECIFICATIONS

GPU	AMD Tahiti Pro
GCN Cores	1,792
Memory Capacity	3GB GDDR5

VERDICT 7

Powercolor R9 280 TurboDuo

⊞ **TURBO** Good 1080p gaming performance; quality memory setup; cool and quiet.

⊟ **TURN OFF** Outdated feature set; power hungry.

$210, www.powercolor.com

XFX R9 270X

Suffering the squeeze

AT $200, THE R9 270X is pushing towards the budget market, but with the midrange and high-end of AMD's current graphics stack seriously compressing, this poor little GPU is really feeling the squeeze. When the R9 285 is only a night's bar tab away and yet is a far more powerful and advanced graphics card, there's no decision to make.

We're once again talking about a GPU only rocking the first iteration of AMD's GCN architecture too. No TrueAudio, no memory compression funk, and not even a sniff of the FreeSync tech. That adds up to an unappealing card but one that demands a surprising amount of power.

The squeeze isn't just coming from a cascade of higher-performance cards either. Nvidia's Maxwell architecture started at the bottom of the market in the GTX 750 and GTX 750 Ti and that surprisingly capable GM 104 GPU really pushes the R9 270X in terms of gaming performance. And costs a good deal less. At this end of the market, being $60 more means a lot. It represents a hefty 40 percent price difference between them.

This is the real problem with the GCN architecture. It works at the high and midrange, where you can get away with being power-hungry and generating a bunch of heat, but at the low end it still needs a lot of power. Maxwell on the other hand has been designed to scale from tablets up to supercomputers and so is far more efficient. XFX's cooling array does its best, keeping things chilled, but can't help the power draw or performance.

SPECIFICATIONS

GPU	AMD Curacao XT
GCN Cores	1,280
Memory Capacity	2GB GDDR5

VERDICT
5

XFX R9 270X Double Dissipation

⊞ **POWER PLAYER** Quality cooling array.

⊟ **POWER HUNGRY** Disappointing performance; last-gen tech.

$200, www.xfxforce.com

Zotac GTX 750 Ti

The great equalizer

THE GTX 750 TI might go down as one of our favorite-ever graphics cards. It represented a shift in Nvidia's scheduling, being the first GPU running on its new Maxwell architecture, but being resolutely low-end.

It was almost like Nvidia saw the writing on the wall regarding the 20nm process transition and was testing how efficient it could get its new architecture on the 28nm lithography before committing its top cards. Almost.

But none of that is why we love the GTX 750 Ti so much. Its real beauty is that it's so low-powered—100W lower peak platform power compared with the closest AMD GPU—and yet still delivers excellent 1080p gaming. We were able to cobble together a passively cooled option which didn't even throttle back its clock speed.

This Zotac version is good. It delivers the necessary gaming performance and does it all cool and quiet, but still demands a PSU power connector. Our favorite GTX 750 Ti cards though take all their power from the PCIe socket itself, making them one-shot upgrades for even that $400 desktop you picked up from Best Buy. Just $140 later and you've got a 1080p gaming machine without needing any other upgrades.

It's the great equalizer. The GPU that can make every PC a gaming PC and for an absolute bargain price. Bless the little GTX 750 Ti. We'd say it's actually more important to PC gaming than the new GTX Titan X.

SPECIFICATIONS

GPU	Nvidia GM 104
CUDA Cores	640
Memory Capacity	2GB GDDR5

VERDICT
9

Zotac GTX 750 Ti

⊞ **MUAY THAI** Stunningly efficient; impressive gaming performance; great price.

⊟ **BYE BYE** This Zotac version does need a 6-pin power connector.

$140, www.zotac.com

HOW WE TESTED

Our GPU test rig is a stock-clocked Core i7-4770K in an Asus Maximus VI Hero Z97 board with 8GB DDR3 running at 1,600MHz. All of our graphics cards are tested with the latest release drivers on the same benchmark settings to ensure a fair test. We've included all the minimum frame rate results as well as the overall average to indicate how smooth an experience you're getting from each graphics card.

SPECIFICATIONS

	Website	Price	GPU	Cores	Memory Capacity	Memory Bus	Peak Platform Power	Peak Temperature ˚C	Score
Nvidia GeForce GTX 980	www.nvidia.com	$550	GM 204	2,048	4GB GDDR5	256-bit	292W	80	8
Sapphire R9 290X Tri-X	www.sapphiretech.com	$350	Hawaii XT	2,816	4GB GDDR5	512-bit	368W	71	9
Gigabyte GTX 970 G1 Gaming	www.gigabyte.com	$350	GM 204	1,664	3.5GB + 512MB GDDR5	256-bit	310W	58	8
XFX R9 290 Black OC Edition	www.xfxforce.com	$306	Hawaii Pro	2,560	4GB GDDR5	512-bit	365W	71	8
HIS R9 280X IceQX2	www.hisdigital.com	$280	Tahiti XT2	2,048	3GB GDDR5	384-bit	351W	69	6
Sapphire R9 285 DualX	www.sapphiretech.com	$250	Tonga Pro	1,792	2GB GDDR5	256-bit	290W	68	7
Asus STRIX GTX 960 OC Edition	www.asus.com	$210	GM 204	1,024	2GB GDDR5	128-bit	247W	58	8
Powercolor R9 280 TurboDuo	www.powercolor.com	$210	Tahiti Pro	1,792	3GB GDDR5	384-bit	308W	67	7
XFX R9 270X Double Dissipation	www.xfxforce.com	$200	Curacao XT	1,280	2GB GDDR5	256-bit	256W	65	5
Zotac GTX 750 Ti	www.zotac.com	$140	GM 104	640	2GB GDDR5	128-bit	160W	62	9

1920x1080 BENCHMARKS (1080p)

	Bioshock Infinite	Battlefield 4	Company of Heroes 2	GRID 2	Shadow of Mordor	Metro: Last Light
Nvidia GeForce GTX 980	**10/116**	**65/103**	**38/55**	**116/147**	**54/87**	**32/53**
Sapphire R9 290X Tri-X	17/107	55/81	27/48	87/115	42/83	25/50
Gigabyte GTX 970 G1 Gaming	17/115	61/92	23/51	104/135	30/77	26/50
XFX R9 290 Black OC Edition	17/101	46/76	32/46	76/105	38/77	8/46
HIS R9 280X IceQX2	17/86	41/64	25/37	70/91	30/60	8/36
Sapphire R9 285 DualX	17/78	34/54	19/33	68/84	16/45	24/33
Asus STRIX GTX 960 OC Edition	19/75	39/58	20/32	70/90	16/36	21/33
Powercolor R9 280 TurboDuo	15/74	36/56	22/31	60/77	26/52	8/31
XFX R9 270X Double Dissipation	16/62	27/46	18/27	46/62	7/19	7/24
Zotac GTX 750 Ti	6/47	26/48	12/24	58/75	14/26	13/27

The initial figures are the minimum frame rate over the benchmark, followed by the average frame rate achieved. All tests are run at their highest settings with 4x antialiasing where possible. Best scores are bolded.

2560x1600 BENCHMARKS (1600p)

	Heaven 4.0	Bioshock Infinite	Battlefield 4	Company of Heroes 2	GRID 2	Shadow of Mordor	Metro: Last Light
Nvidia GeForce GTX 980	**21/41**	**19/78**	**35/61**	**22/30**	**80/101**	**40/57**	**21/30**
Sapphire R9 290X Tri-X	**17/34**	**16/66**	**34/53**	**15/29**	**66/82**	**29/60**	**17/28**
Gigabyte GTX 970 G1 Gaming	19/34	21/70	40/55	21/29	71/91	20/49	21/28
XFX R9 290 Black OC Edition	17/32	16/63	29/48	18/27	58/74	27/56	8/26
HIS R9 280X IceQX2	14/25	16/50	22/40	15/22	48/66	21/43	7/21
Sapphire R9 285 DualX	12/21	14/45	20/32	7/12	46/59	13/32	13/18
Asus STRIX GTX 960 OC Edition	11/20	17/43	24/33	1 /17	45/59	11/26	13/18
Powercolor R9 280 TurboDuo	13/22	17/43	20/34	13/18	44/56	19/39	7/18
XFX R9 270X Double Dissipation	10/17	12/34	15/28	0.5/9	33/43	5/14	6/13
Zotac GTX 750 Ti	9/14	9/27	15/27	7/14	31/48	8/15	10/15

The initial figures are the minimum frame rate over the benchmark, followed by the average frame rate achieved.
All tests are run at their highest settings with 4x antialiasing where possible. Best scores are bolded.

3840x2160 BENCHMARKS (4K)

	Heaven 4.0	Bioshock Infinite	Battlefield 4	Company of Heroes 2	GRID 2	Shadow of Mordor	Metro: Last Light
Nvidia GeForce GTX 980	**12/19**	**20/43**	**22/34**	**10/15**	**44/58**	**16/32**	**12/16**
Sapphire R9 290X Tri-X	**10/17**	**16/35**	**12/32**	**8/16**	**44/54**	**18/36**	**10/14**
Gigabyte GTX 970 G1 Gaming	10/16	17/37	20/29	5/14	38/55	14/28	11/14
XFX R9 290 Black OC Edition	10/16	15/33	17/28	10/15	36/47	17/33	5/13
HIS R9 280X IceQX2	8/13	13/27	13/23	3/5	31/41	10/21	5/11
Sapphire R9 285 DualX	6/10	10/23	7/17	2/5	29/35	6/18	3/9
Asus STRIX GTX 960 OC Edition	5/9	8/21	10/13	3/4	26/34	7/14	5/9
Powercolor R9 280 TurboDuo	7/11	11/23	12/20	4/6	25/35	9/19	4/9
XFX R9 270X Double Dissipation	5/8	7/16	7/13	0.3/1	22/27	4/7	2/7
Zotac GTX 750 Ti	4/7	6/13	8/16	1/5	22/29	8/11	4/8

The initial figures are the minimum frame rate over the benchmark, followed by the average frame rate achieved.
All tests are run at their highest settings with 4x antialiasing where possible. Best scores are bolded.

And the winner is...

Sapphire R9 290X Tri-X

IT'S ACTUALLY QUITE A FRUSTRATING time to be reviewing a whole pile of graphics cards. Nvidia has pretty much shot its Maxwell load now, dropping new cards into the high, mid, and low-ends of the market. And now it's topped all that off with the ultra-enthusiast GTX Titan X, and cheaper GTX 980 Ti, we've reviewed separately over the page. Both missed the deadline for this group test, so aren't included.

But AMD is still holding onto its Pirate Island range of cards. Which means there are no new Radeons in this test. It also explains why prices have been compressed and why there's so little between the cards throughout its current stack. The good news is that the price compression has helped create a couple of diamonds, from a value point of view.

There's a fair amount of detritus, however, so we can quickly discard both the Tahiti-based cards—the R9 280 and R9 280X. They're still remarkably capable gaming cards, and if you've already got a R9 280 sat in your rig right now, then picking up another for just $210 will deliver some quality gaming performance. But they're getting fairly long in the tooth and are lacking the feature set of AMD's later GCN cards, most especially the promising FreeSync tech.

LORDING THE LOW-END

We can also ditch the R9 270X too. There's pricing pressure coming its way from both above and below, courtesy of the R9 285 and the GTX 750 Ti. While the Radeon has higher performance for only a little more money, Zotac's GTX 750 Ti trades benchmark wins with it, while letting you walk away having spent a chunk less cash.

Speaking of the GTX 750 Ti, as we like to do, it's still our favorite budget card, possibly our favorite graphics card ever. At $140 it's a great upgrade for literally any low-end desktop PC, especially if you get one that's entirely bus-powered. It's how you can build yourself a 1080p gaming rig for the same price as a weak-heart console box.

In the midrange there's a bit of a battle royale going on between the R9 285 and the GTX 960. The 285 is sitting at a great price right now and they both deliver similar levels of gaming performance. But the elegant GTX 960 is cooler, quieter, and less power-hungry. Combined with the supporting Nvidia ecosystem, throwing MFAA and GFE into the mix, that just about gives the GeForce card the edge in this one.

At the top of the tech tree things are just as tight. The GTX 970 is a fantastic little card, especially in this Gigabyte version—don't blame the 970 for Nvidia's mess up, it wasn't its fault. But at $350, its performance lead over its closest rival isn't quite enough to justify the extra expense. And that card has a *proper* 4GB frame buffer...

So, it's up to the GTX 980 and R9 290X to fight things out at the very top of this supertest. All things being equal, the Nvidia card is obviously the better option. The impressive GTX 980 is powerful and efficient while third-party 0dB coolers ensure it stays completely silent until it really gets going. But things are not equal. The GTX 980 is currently a full $200 more expensive than the excellent Sapphire R9 290X Tri-X card. The 980's unambiguous performance lead simply can't justify such a huge disparity in price.

Real world result: We'd want the GTX 980 card, but we'd buy the Sapphire.

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Nvidia GeForce GTX Titan X

IN ANCIENT GREEK MYTHOLOGY, the Titans are the immediate descendants of the primordial gods. So it is with the Nvidia GeForce GTX Titan, offspring of the company's top-shelf professional workstation GPUs. First debuting in March 2013, the original Titan was nearly the most powerful videocard Nvidia could offer. But it sealed off a couple of items of little interest to gamers, items which also prevented professionals from using these less expensive variants for workstation duties. Now the time has come for the GTX Titan X, based on Nvidia's Maxwell generation of GPUs. And it's a beast. Despite being stuck on 28nm for several years, the firm continues to extract more and more performance from its silicon. The Titan X also has an almost ridiculous 12GB of GDDR5 VRAM, and one billion more transistors than the original Titan.

Yet it still draws about 250 watts under load despite higher clock speeds, and its cooler is noticeably quieter. Despite all the silicon, it still uses Nvidia's reference dimensions; it's only about 10.5 inches long, and it's not taller or wider than the slot bracket. If not for its darker coloring, you could easily confuse it for any baseline Nvidia card from the past couple of years. Its FP64 performance has been cut to the bone, though. So now more than ever, the Titan X is an executive-class gamer card.

Unfortunately, like earlier Titans, Nvidia won't allow vendors to use their own coolers, so you're stuck with this reference design unless you get EVGA's Hydro Copper

TITAN
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A new hero descends from Mount GeForce

version, or you try something like an Arctic Cooling Accelero Hybrid.

We've been testing with a mix of AMD-friendly and Nvidia-friendly titles (it seems you're either one or the other, these days)—*Metro: Last Light*, *Hitman: Absolution*, and *Tomb Raider* usually favor AMD; *Batman: Arkham Origins*, *Shadow of Mordor*, and Unigine Heaven favor Nvidia. In all cases, we use their built-in benchmarks.

THE CHOSEN ONE?

The cards we tested the Titan X against all comfortably sustain 60-plus fps at 1080p, but older GPUs struggle to maintain that threshold at 2560x1440, as does the GTX 970. We're pushing 77 percent more pixels onto the screen, and the original Titan's relatively low number of ROPs, low clock speeds, and Kepler-gen CUDA cores combine to make an obstacle that the other cards don't have to deal with. The new Titan X is producing well over 50 percent more frames than the original Titan in some of these tests. Wringing these kind of gains from the same 28nm process is pretty impressive. It comfortably beats AMD's best card in every test.

We want to see how these cards perform when pushed to the limit, not just playable frame rates. Despite these demands, the Titan X remains a viable solo card to have at 4K, though it's still not ideal (putting aside the technical resolution difference between DCI 4K and Ultra HD 4K). The good news is that 4xMSAA is arguably not needed at a resolution this high, unless you're on a big 4K HDTV a couple of feet away.

Overall, things are looking rosy. Since it's packed with a huge amount of render output units, streaming multiprocessors, CUDA cores, and VRAM, the Titan X can overcome the limitations of the aging 28nm process. The Maxwell-generation CUDA cores are also about 40 percent faster than the older Kepler version (by Nvidia's estimation, at least). It's not the Chosen One if you want to game with a single GPU at 4K, but you can get pretty close if you're willing to tweak a few graphical settings. **–TOM MCNAMARA**

SPECIFICATIONS

GPU	GM 200
Lithography	28nm
Transistor Count	8 billion
Die Size	601mm^2
SMM Units	24
CUDA Cores	3,072
Texture Units	192
ROPs	96
Base Clock	1,000MHz
Boost Clock	1,075MHz
Memory Capacity	12,288MB GDDR5
Memory Bus	384-bit
Memory Clock	3,505MHz
TDP	250W

VERDICT
9
KICK ASS!

Nvidia GeForce GTX Titan X

⊞ **GIN AND JUICE** Warp-speed performance; piles of VRAM; compact and fairly quiet.

⊟ **PURPLE DRINK** Steep price tag; limited cooling options.

$999, www.nvidia.com

BENCHMARKS

	Metro: Last Light	Batman: Arkham Origins	Hitman: Absolution	Middle-earth: Shadow of Mordor	Tomb Raider	Unigine Heaven
GTX Titan X	**64/35**	**90/53**	**60/33**	**77/44**	**129/60**	**61/26**
GTX Titan	44/24	58/34	43/22	49/25	77/37	38/18
GTX 980	59/32	71/41	46/24	67/37	105/48	48/20
GTX 970	47/24	59/32	39/19	51/28	81/37	36/15
GTX 780 Ti	51/27	62/38	48/23	56/32	86/40	42/19
GTX 780	47/26	59/35	44/23	52/30	80/38	40/18
Radeon R9 290X	54/28	83/41	54/29	63/37	91/43	40/17

Best scores are bolded. Results are fps at 1440p, followed by 4K. Our test bed is a 3.33GHz Core i7-3960X Extreme Edition in an Asus Rampage IV Extreme motherboard, with 16GB of DDR3/1600, and a Corsair AX1200. The OS is 64-bit Windows 8.1.

The Titan X has an HDMI 2.0 connector, which can do 4K at 60Hz.

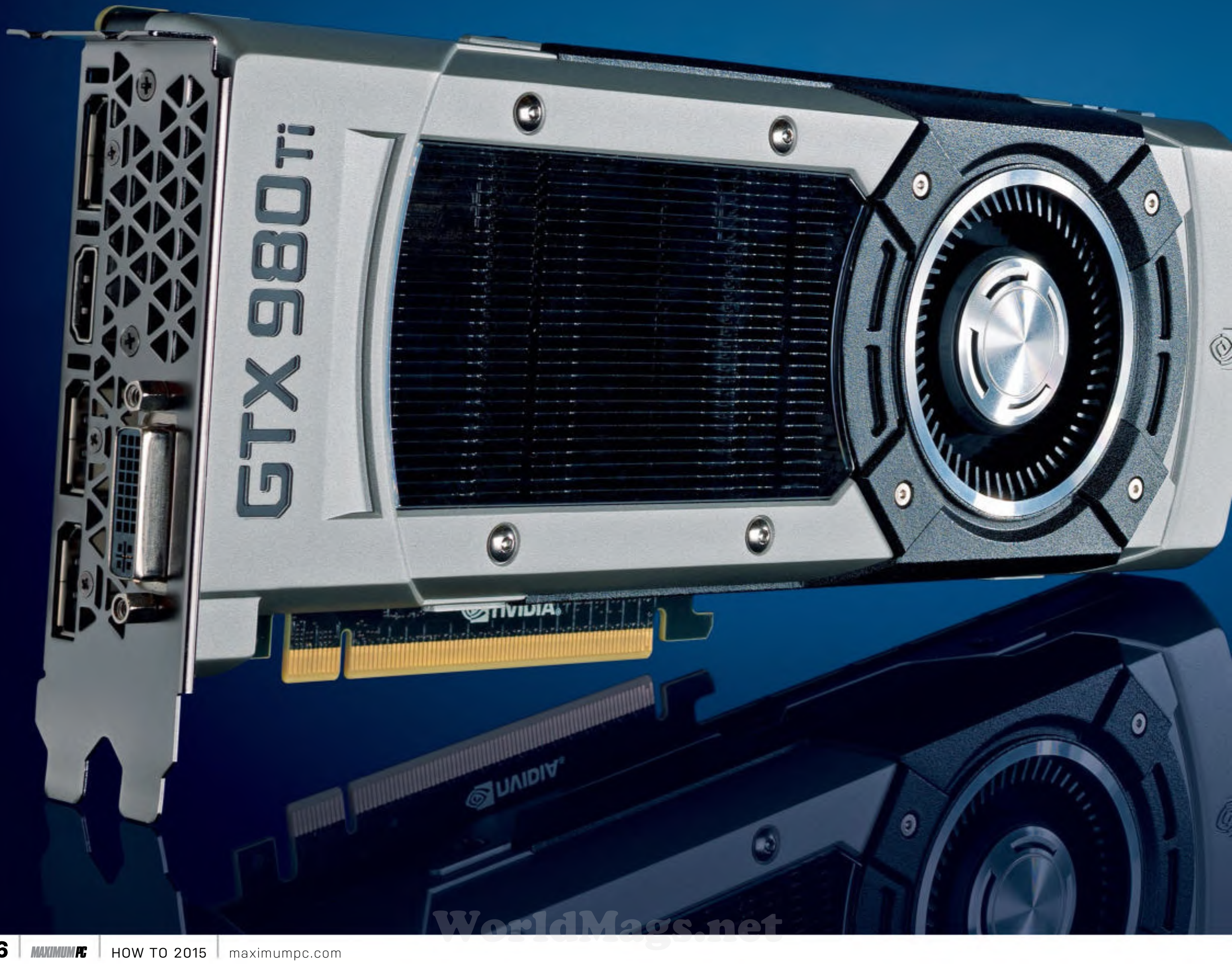
Nvidia GeForce GTX 980 Ti

OTHER THAN THE DROP in the number of shaders/SMMs, the 980 Ti looks a lot like Nvidia's other GM200 chipped card, the Titan X, but for less of the folding green. It still has 96 ROPs and a 384-bit GDDR5 interface, though "only" with 6GB VRAM this time. We're already seeing signs of 4GB VRAM being insufficient, particularly for higher resolution modes like 4K, but with very few cards sporting more than 4GB VRAM most games are unlikely to need 12GB VRAM. A nice 6GB on the other hand, yes, thank you, we can definitely use that! It's also important to note that there are none of the 3.5GB + 512MB segmented memory shenanigans of GTX 970 at play with the 980 Ti; this is a fully enabled GM200 chip as far as the memory interface and cache are concerned. That means in situations where games don't need more than 6GB VRAM, the 980 Ti should be no worse than 8 percent slower than a Titan X.

We've already covered most of the other interesting tidbits for the GM200 in our Titan X review on page 34. It has 8 billion transistors compared to 6 billion in the GM204 (and 5.2 billion in GK110). The chips are divided into SMMs—"streaming multiprocessors"—each of which contains 128 CUDA cores subdivided into four warp schedulers of 32 cores each. Each SMM also has 16 Texture Units (TMUs), a 96KB memory pool, and another 48KB of shared L1/texture cache. The main difference here is that the 980 Ti disables two of the SMMs while keeping everything else in place.

While the basic design of Nvidia's first- and second-generation Maxwell parts is the same, it's important to note that only second-generation Maxwell processors support several new features: DSR (Dynamic Super Resolution), third-generation Delta Color Compression, Multi-Pixel Program Sampling, VXGI (Voxel Global Illumination), VR Direct, Multi-Projections Acceleration, and MFAA (Multi-Frame Sampled Anti-Aliasing). HDMI 2.0 is also supported on second-generation Maxwell, which means you can do things like drive a 4Kp60 display without resorting to any compression algorithms.

There are some other interesting tidbits at play here. For example, even though the 980 Ti has fewer cores than the 780 Ti,



The little brother to the GeForce GTX Titan X

the Maxwell 2.0 cores are more efficient. The GTX 980 is already able to match or slightly exceed the performance of the 780 Ti with 2,048 cores, so accounting for clock speeds the 980 Ti should be at around 15–20 percent faster than the GTX 980. In situations where the VRAM amounts come into play (e.g., at 4K resolutions), the performance delta will potentially be even greater. Nvidia claims that the 980 Ti is as much as 65 percent faster than the 780 Ti at 4K resolutions, and compared to the GTX 680 it's claiming up to a 3x increase in performance. Those are lofty claims, and realistically, that "up to" phrase is pretty nebulous; on average, the increase will often be less substantial, except in cases where you run out of VRAM.

STAYING COOL

The GTX 980 Ti reference design retains Nvidia's proven cooling solution from the Titan X and earlier GPUs. It has worked well and manages to provide good cooling without generating a ton of noise, so it's no surprise to see it appear yet again. Unlike the Titan X, however, add-in board manufacturers are free to experiment a bit more with the 980 Ti, so while our test GPU looks exactly like a Titan X, other than the 980 Ti logo emblazoned on its side, we're likely to see open-air coolers as well as blowers from the likes of EVGA and Asus.

Just as expected, the GTX 980 Ti is a force to be reckoned with in our benchmarks. For those with an older GPU like the GTX 770 (which is about 10 percent faster than a GTX 680), the GTX 980 Ti represents an astounding doubling of performance at our 1080p and 1440p settings; if you happen to run 4K games at maxed-out settings, we actually averaged more than a 3x improvement in performance. That's mostly thanks to a couple of games that did very well—*Tomb Raider* shows a 4.7x improvement and *The Witcher 3* shows a 5.8x improvement. Then again, *Batman: Arkham Origins* failed to run on the GTX 770 with our 4K settings, so in that sense the improvement is even better. Practically speaking, it means you can go from an unplayable single-digit gaming experience at 4K maximum quality on the 770 to a reasonably playable 30+fps experience. Of course, you can get far better 4K performance if you disable AA and turn a few settings down a notch.

If you already have a good GPU, the 980 Ti isn't going to provide nearly as much benefit. Compared to the 970, it's a reasonable bump in performance of 55-65 percent, but compared to the GTX 980 it's a much smaller 20–25 percent improvement. The R9 290X continues to show its potential, especially at higher resolutions where on average it's only 10 percent slower than the GTX 980. That makes the 980 Ti 35–40 percent faster than the 290X, but you could buy two AMD R9 290X GPUs instead of the 980 Ti and still have money left for lunch. That's the difficulty Nvidia needs to overcome when it comes to convincing gamers to buy their latest "affordable" powerhouse.

The two-word summary of the GTX 980 Ti is this: It's awesome! With the Xbox One and PlayStation 4 both sporting 8GB total RAM, we're seeing many titles push beyond the 2GB mark that has been around for so long. Couple that with 4K displays and we've rapidly gone from 2GB being "enough" and 4GB being "future-proof" to a new level where at least 6GB is necessary if you want to enable maximum quality. Like the Titan X, the 980 Ti makes sure you have enough VRAM, and then it tosses in a bunch of bandwidth and shaders as a bonus. **–JARRED WALTON**

VERDICT
9
KICK ASS!

Nvidia GeForce GTX 980 TI

➕ **BUZZING** The GTX 980 Ti performs better than any other GPU besides the Titan X.

➖ **FLY IN THE OINTMENT** Wait for AMD's Fiji with HBM to be released.

$649, www.nvidia.com

BENCHMARKS

	Batman: Arkham Originst	Hitman: Absolution	Metro: Last Light	Middle-earth: Shadow of Mordor	Tomb Raider	Unigine Heaven 4
GTX 980 TI	**181/110/53**	**93/63/32**	**103/69/37**	**113/81/46**	**130/86/43**	**97/60/25**
GTX 980 SLI	141/85/42	75/50/25	92/60/31	94/68/38	112/73/35	79/48/20
Radeon R9 290X	129/81/40	75/53/28	78/52/27	85/63/37	84/58/29	61/38/16
GTX 970	113/67/32	62/40/19	70/46/24	72/51/28	83/55/26	57/34/15
GTX 770	101/61/0	52/34/17	58/38/19	41/31/17	63/41/9	46/28/12

Best scores are bolded. Results are fps at 1080p/1440p, followed by 4K. Our test bed is an Intel Core i7-5930K (4.2GHz overclock), Gigabyte GA-X99-UD4 motherboard, 2x Samsung 850 Evo 250GB SSD and a Seagate Barracuda 3TB 7200RPM HDD, G.Skill Ripjaws 16GB DDR4-2666.

SPECIFICATIONS

GPU	GM 200
SMM	Units 22
CUDA	Cores 2,816
Texture Units	176
ROPs	96
Base Clock	1,000MHz
Boost Clock	1,075MHz
VRAM	6GB
Memory Bus	384-bit
TDP	250
Shaders	2,816

The GTX 980 Ti disables two of the SMMs while keeping everything else in place.

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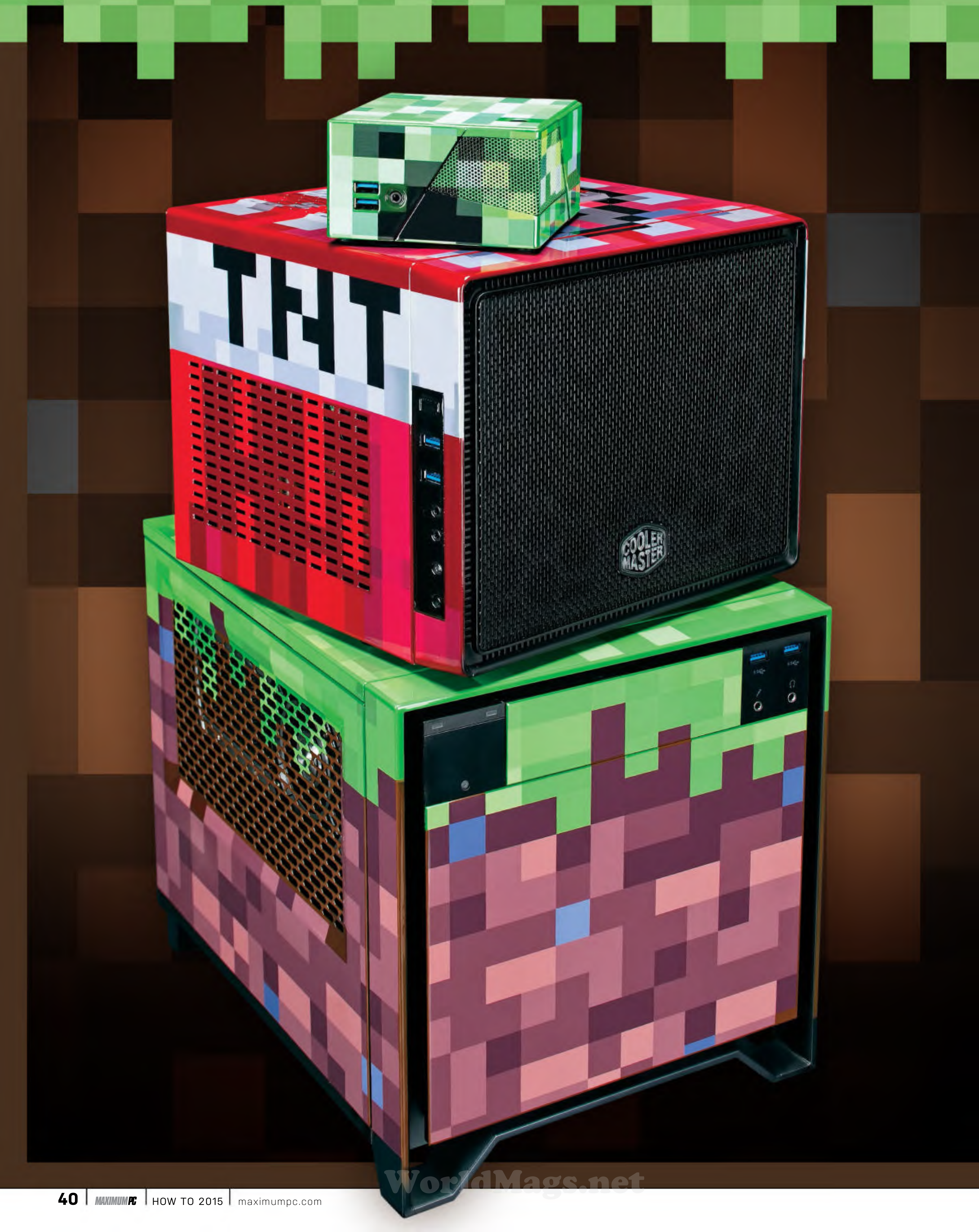
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THE GEARHEAD'S GUIDE TO MINECRAFT

How to build an amazing experience with the right tweaks, mods and hardware

by **Tom McNamara**

Computer games age in dog years, and *Minecraft* has been around since 2009. So by most measurements, it should be in the old folks' home, laid back in a recliner, watching reruns of *Jeopardy*, and gumming some tapioca. Instead, the game is a true phenomenon. Like *World of Warcraft* or *Counter-Strike*, it's fun, plus frequently evolves to keep things interesting.

With this game, you can take several *actual* months just building your own personal fortress, one digital block at a time. Or you can hop on a multiplayer server and help people build cool stuff until the break of dawn. Each world you create is also randomly generated, so it's never the same place twice. (If you've never tried *Minecraft* and you'd like a basic introduction, check out http://bit.ly/MPC_MCbeginner for our friendly online guide.)

Some of *Minecraft*'s huge runaway success—almost 17 million have bought the game—can be attributed to its relatively low system requirements. It'll run fine on machines that were left behind long ago by other games. But don't take that to mean you'll want to play it on integrated graphics, as you can pile up mods to push even high-end hardware to the limit. We've the secret sauce ingredients to make this game shine in a way you might never have witnessed before. And of course, we'll show you three of the most stunning *Minecraft* PCs you've ever seen.

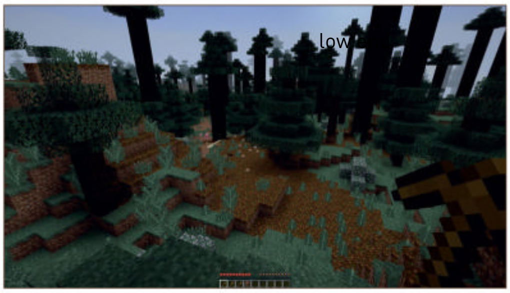
THE BASE GAME IS JUST A STARTING POINT

MILLIONS OF GAMERS CAN'T BE WRONG

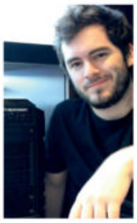
A screenshot of *Minecraft* should be a familiar sight to every gamer. You probably went through a *MC* phase yourself, and haven't played the game in a few years. Perhaps you feel content with memories and see no need to go back. Well, if you've never modded *Minecraft*, you're wrong. If you've tried one or two texture packs, you're still wrong. You rode a bicycle when you could've been chauffeured in a limousine. That's OK, we all make mistakes.

Like the game itself, you won't see the potential until you start digging. We dug deep and found glittering gems. While the default *Minecraft* is full of blocky objects, ugly textures, and jaggy edges, we can make it look pretty after a half an hour of work. And it won't cost a dime. Like with *Skyrim*, there's a small army of modders adding stuff you didn't think could exist, from sparkling waterfalls to gently swaying grass.

If you have an entry-level PC, you can still boost your performance. When we started *Minecraft* back in the day, it was with a single-core AMD Athlon 64 4000+, 2GB of RAM, and a Radeon X1550 with 256MB of GDDR5 onboard, so we sympathize with low-end struggles. Back then, we tinkered with every setting, like a mechanic tuning an aging minivan. And with enough duct tape and elbow grease, we got it to work. On the next page, we'll explain the settings that can make a difference with modest hardware.



Every empire begins with a single block of grassy dirt.



TALKING RIGS WITH YOUTUBE PHENOMENON JORDAN *"CAPTAINSPARKLEZ"* MARON

With almost 8 million subscribers, Jordan Maron, aka CaptainSparklez, is one of the highest-ranked Youtube personalities on Earth and instantly recognizable as a *Minecraft* celebrity. We caught up with the good Cap'n and grilled him on how he got his start and the hardware he runs. –GU

MPC: YOU'RE ARGUABLY THE ORIGINAL *MINECRAFT* YOUTUBE CELEBRITY. CAN YOU TELL US HOW YOU GOT ON THIS PATH?
CAPTAINSPARKLES: I don't know about the original, nor the celebrity part, but I've been doing it for what feels like a while, at least as far as Internet time goes. I was initially shown the game by a friend who was quite bananas about it, so I gave it a try myself, uploaded a few videos, and the reception was pretty super, so I stuck with it.

MPC: SO, WHAT'S A TYPICAL DAY LIKE FOR CAPTAINSPARKLEZ?
CS: Nothing too glamorous. Lots of sitting at my computer finding new things to record, recording them, browsing, and reading articles. Occasionally I'll venture out of my cave into the scary place known as outside for a meeting or some skateboarding.

MPC: NOW, ONTO THE HARDWARE...
CS: I've got a 3.5GHz Core i7-3970X running at stock speed, GeForce GTX Titan, 32GB RAM, 500GB SSD, and a 2TB hard drive. I've got it hooked up to three 1920x1080 monitors—two 23s and a 24-inch.

MPC: WHY DID YOU PICK THOSE PARTS?
CS: Given the gaming, editing, 3D animation, and rendering I do, it's in my interest to have the fastest machine possible, so I just opted for what I felt to be top-of-the-line at the time. It's probably not the most cost-effective build, but it's served me very well.

MPC: DO YOU RUN ANY SPECIAL MODS?
CS: No "special" mods, but when I pile on 100 of them, it helps to have good hardware. Even then there can still be a fair amount of lag at points. I suppose some of the shader mods get a performance boost from the Titan; I had some trouble running them on my old machine, but they are pretty flawless now. Those shader mods are super cool, by the way; looks like nothing you'd have thought possible in *Minecraft*.

MPC: DO YOU BUILD OR BUY YOUR PCS?
CS: This is the bit where I fess up. I don't assemble my own PCs. I've heard too many complaints from friends who built computers only to find they wired something wrong, troubleshoot, then find out a part arrived broken, figure out which one, replace, and repeat the process. It isn't something I find fun, so I pay the premium to pick up a finished rig a week after ordering.

MPC: WHAT HARDWARE CONFIGURATION DO YOU RECOMMEND FOR *MINECRAFT*?
CS: Folks may consider it overkill, but if you're playing *Minecraft*, you're probably playing other games as well, so as a general PC building recommendation I suggest the Core i7-4790K. It should do everything you'd hope for a long while to come. I'd also recommend something like a GeForce GTX 760, at least 8GB RAM, and possibly a 256GB SSD if you're feeling fancy. The whole setup shouldn't cost too much more than $1,000.

PERFORMANCE TIPS

DON'T GET SHAFTED WITH SUBSTANDARD MINECRAFT *PERFORMANCE*

When you start the game and click on the "Options" menu, you'll see one visual setting: FOV (Field of View). That's basically the cone of vision in front of you. The "Normal" setting is 70 degrees wide, but the slider goes from 30 to 110. If first-person games make you feel nauseated, you may find some relief by increasing the FOV to 80, 90, or even higher. This will create a sort of fish-eye camera effect at the highest level, but it's preferable to losing your lunch. Click on the "Video settings" to get to the meat of the performance settings.

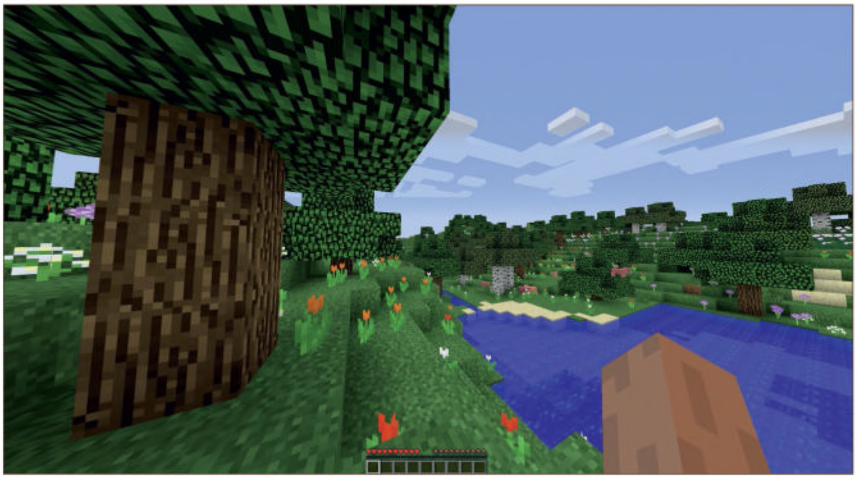
Graphics has two settings: "Fast" and "Fancy." The latter enables transparency, shadows, enhanced water effects, and better-looking clouds. Almost every setting in this menu will take effect without requiring a restart, so you can go back and forth to see the effect that different settings have on your performance. If you press "F3" while playing the game, you'll get a frame rate counter in the upper left-hand corner, among other things. This will put a lot of text on the screen. You can make this smaller by changing the GUI Scale to "Normal" or "Small."

UNLOCKING FRAME RATES

Setting Smooth Lighting to "Maximum" creates smaller gradients of light from one block to another. The actual Brightness setting has no impact on performance and is purely a matter of taste, though it can help you distinguish certain types of blocks in dimly lit areas. The particle setting determines whether or not you see debris or dust when you run around or chop a tree, and liquid spray.

Vsync attempts to lock your frame rate at 60fps, if your monitor has a 60Hz refresh rate. If your PC can't maintain that, your fps gets knocked down to 30. If you can't maintain that, then vsync drops you to 20. And so on. We recommend disabling it and using Adaptive V-Sync for Nvidia GeForce video cards, or Dynamic V-Sync for AMD Radeon video cards. This will automatically disable vsync when your fps falls below 60, and re-enable vsync when your frame rate goes back up.

Anisotropic filtering increases the sharpness of textures that are distant from the player. This one usually doesn't impact performance very much, so you should be able to crank it all the way to 16. Render distance determines how much of the game world you actually see around you. Adding more chunks pushes the horizon back, but it can cause stuttering as the game takes a moment to draw that area. The Max Framerate setting can be ignored if you're running a standard 60Hz monitor. Dynamic/adaptive vsync will override it.


A wide FOV stretches objects on the edge of the screen but can help with motion sickness.

SMOOTHING IT OUT

Advanced OpenGL enables a feature called Occlusion Culling, which basically tells your video card to not render things that the player can't see. Some very old GPUs don't support this.

Disabling clouds can increase your performance and may help with certain visual glitches. The fullscreen toggle has minimal impact on performance if the game window is already maximized. If you leave fullscreen off, this will make it easier to Alt-Tab to other windows. Mipmap levels smooth out surface detail according to distance from the player, but higher levels need to be balanced with anisotropic filtering to prevent excessive blurriness.

Installing the Optifine mod (detailed in the next section) adds a host of additional video settings that would require an additional article to fully cover. Thankfully, the mod provides pretty informative tool tips that pop up when you hover over each setting. Generally, we recommend only changing a few settings at a time, so you know which one has the most impact (or which one is causing glitches). It also automatically enables the use of a second CPU core (vanilla *Minecraft* is only single-threaded), which can improve frame rates right away.

> "We recommend only changing a few settings at a time, so you know which one has the most impact (or which is causing glitches)."

MODDING MINECRAFT

ADD FEATURES, BOOST PERFORMANCE, AND MAKE THINGS PRETTY

Out of the box, *Minecraft* is a spiffy game. But it clearly ain't the belle of the ball. Its blocky objects and pixelated textures are an acquired taste, like black coffee or limburger cheese. And you've probably noticed its performance can get pretty chunky, too. Thankfully, a veritable cottage industry of mods has grown up around the game. You can smooth out those textures, or make them even more retro. You can add nice lighting effects, too.

Unfortunately, getting these mods to all play nice with each other is still surprisingly tricky, despite the game being in active development for more than five years now. So let's start simple, with the texture packs.

A WHOLE NEW WORLD

There are piles of websites dedicated to downloadable *Minecraft* content, but for texture packs (referred to as "resource packs" by the *Minecraft* community), we stuck mostly to www.planetminecraft.com and www.curse.com (the latter of which has content for a bunch of other games, too). We prefer these two sources because of easy navigation and sorting. Pixel count is one thing to sort for. The textures can range from 8x8 pixels to 512x512. For reference, the vanilla textures are 16x16. Higher pixel counts can add realism, but this requires more hardware horsepower. You have to strike a balance depending on your situation. Try to get the most up-to-date packs, otherwise you can end up with an awkward mix of modded and vanilla textures.

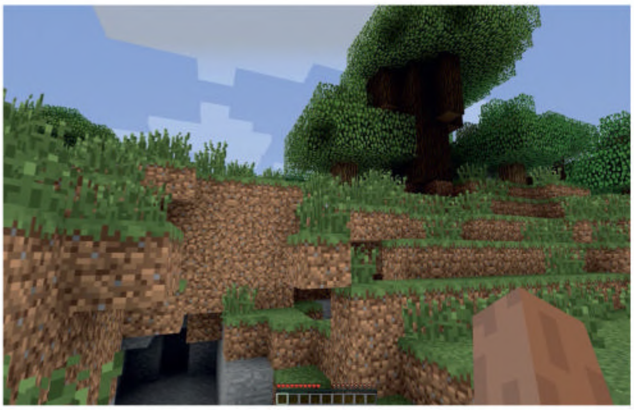
If you have a 64-bit CPU and a 64-bit operating system, we recommend installing the 64-bit version of Java. Go to java.com, click on the "Free Java Download" button, then click on the link labeled "See all Java Downloads" and select "Windows Offline (64-bit)." This version does not check for updates, though, so you have to remember to do that on your own.

FEELING RESOURCEFUL

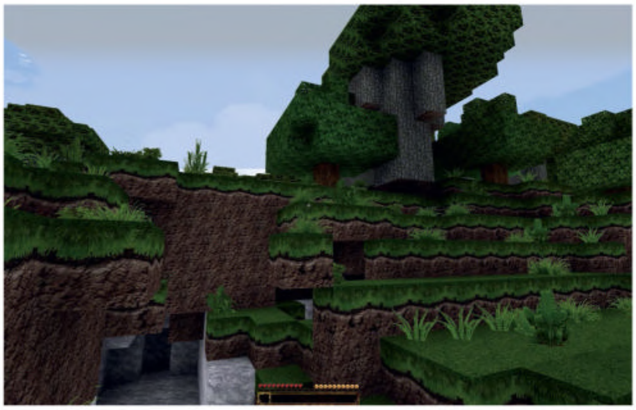
Some of these packs may instruct you to use MCPatcher HD, a Java program that helps these packs integrate into the game. Just Google the name of the program to find a link to www.minecraftforum.net (the official forum) that provides legit download links. Basically, once you've Java installed, double-click on the MCPatcher file to run it like any other program, and click the "Patch" button on the bottom.

When you've downloaded a resource pack, fire up *Minecraft*, click on the "Options" button, select "Resource Packs," and click the button that says "Open resource pack folder," where you can drop in all your packs. Use this opportunity to create a folder shortcut on your desktop. Then click "Done" and the "Resource Packs" button again, and your packs should show up. Click on the one you want to use to activate it, and click the "Done" button again. The more complex the pack, the longer it will take *Minecraft* to load it up. Windows may even tell you the program is no longer responding. If that's still the case after a minute, you may need to force-close the program and try a less complex pack.

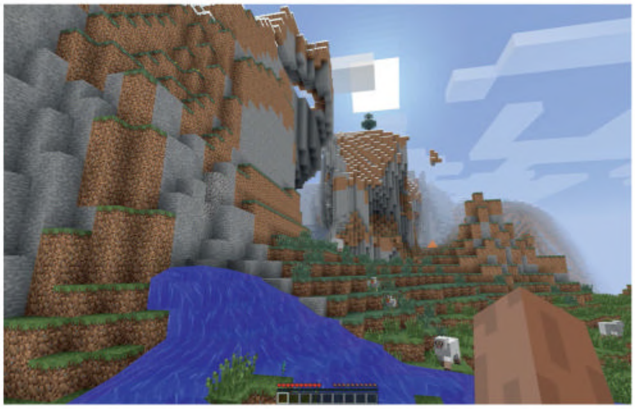
> "Higher pixel counts can add realism, but require more hardware horsepower, so strike a balance."



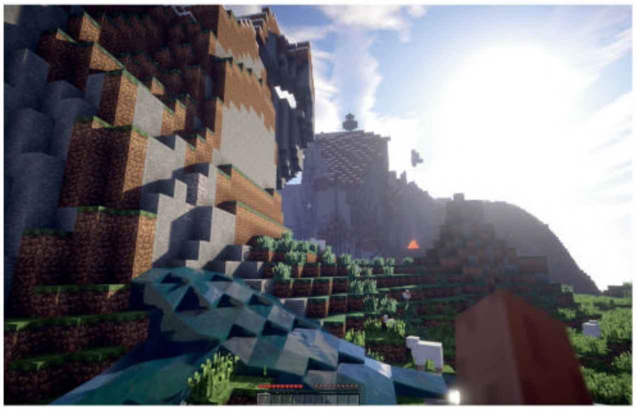
Vanilla *Minecraft* textures date back to the mid 1990s...



... but resource packs such as KoP Photo Realism change everything.



Here's some interesting terrain in the vanilla version...



... now add the Traditional Beauty resource pack and SEUS Shaders.

FIFTY SHADERS OF GREY

There are some things that no resource pack can address. What if you want to see tree branches and grass sway in the wind? What if you're not happy with the way the game's lighting works? That's where shader mods come in. Adding these to the game is a three-step process. First, we install a mod loader, then we install the shader framework, and finally, we install the actual shader pack.

The Minecraft Forge API (Application Programming Interface) is our mod loader. Visit www.minecraftforge.net to grab that. As with the resource packs, get the one that matches your game version. There may be “latest” and “recommended” variants. The latter usually has wider compatibility with the available mods. Before installing Forge, run the game once to set its environment correctly, then shut it down. To install Forge, just double-click on the “EXE” file to install it like any other program.

SEEKING SEUS

Next, you need the GLSL Shaders Mod to enable shader packs. This one doesn't have its own website and instead resides on the *Minecraft* forums. If you do a Google search on the mod's name, the forum link should be your top search result. Download the mod from there, double-click on that “resourcepack” desktop shortcut you created earlier, go one folder up to the one labeled “.minecraft,” and open the “mods” folder. Drop the Shaders Mod in here. Go back to “.minecraft” and open the “shaderpacks” folder next.

We used Sonic Ether's Unbelievable Shaders (SEUS) for this article. It's available at sonicether.com. If you have a high-end PC, choose an “Ultra” version. Midrange PCs will be better off with “Standard,” and entry-level rigs should stick to “Lite.” Download your chosen version and drop it in your “shaderpacks” folder. Then start *Minecraft*, select the “Forge” profile from the drop-down menu in the lower left-hand corner, click “Play,” then select “Options,” choose “Shaders,” and click on the name of the shader to activate it.

FORGING AHEAD

Lastly, you can grab the Optifine mod, available at optifine.net, to boost performance and further beef up your visuals. You can use this one with or without Forge. Next choose the right version for you. The “Ultra” version has the most enhancements, “Standard” is the most compatible, and “Light” is good for laptops and budget PCs but won't work with mod loaders such as Forge. Without Forge installed, just download the “.jar” file and double-click to load the installer. With Forge installed, drop the “.jar” file in the “mods” folder mentioned earlier. If you get stuck somewhere, this mod has its own thread on the official forums with detailed advice for troubleshooting.

> "If you want to see grass sway in the wind or you're not happy with the lighting, shaders are for you."

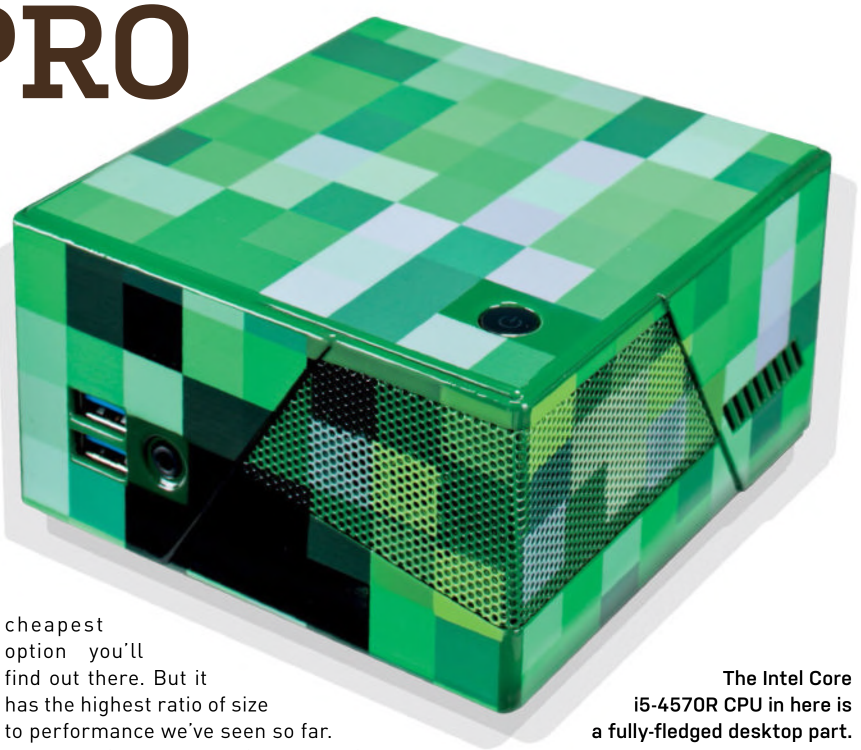
MINECRAFT AT 4K? YES AND NO...

Since *Minecraft* doesn't demand much of your hardware, we hooked up an Ultra HD monitor to see what kind of frame rate we would get with the resolution cranked to 3840x2160. At four times the res of a 1080p monitor, things can start to get chunky. But even the integrated graphics of a quad-core Intel Core i5-4570R could maintain around 60fps, as long as we didn't install any shaders. A system with an Intel Core i7-4770K and a GeForce GTX 780 Ti, meanwhile, flew along at 250–300fps in vanilla mode. When we activated a shader, though, it dropped down to about 35fps. It could be that the shader itself needs some optimization, or that the shaders just put a lot of strain on the GPU. Back down at 1080p, the 780 Ti system maintained about 60fps with all shader effects enabled. Check out the next few pages to get the nitty-gritty on the three systems we built to play *Minecraft*.

THE GIGABYTE BRIX PRO

THIS LIL' GUY WILL CREEP UP ON YOU

Since *Minecraft* doesn't use more than two CPU cores (and even then, not without a mod), and a video card is more of a recommendation than a necessity, we can get up and running with a very compact and portable unit. Enter the Brix Pro series. We reviewed the Intel Core i7-4770R version in the March issue and gave it our Kick Ass award. This one is nearly identical; the CPU here is the i5-4570R, which doesn't have Hyper-Threading. We still get Intel's Iris Pro 5200 graphics integrated into the CPU, and the 128MB L4 cache, plus an mSATA slot, 2.5-inch drive bay, and a pre-installed 802.11ac Wi-Fi card with Bluetooth 4.0. And with four USB 3.0 ports, an HDMI port, Ethernet port, and mini-DisplayPort, we're not lacking for external connections.



The Intel Core i5-4570R CPU in here is a fully-fledged desktop part.

MINECRAFT CUBED

With a street price of $470, plus buying your own Windows license, RAM sticks, and an internal storage device, the GB-BXi5-4570R is certainly not the cheapest option you'll find out there. But it has the highest ratio of size to performance we've seen so far. As you might have noticed, the little fella is also very cube-shaped, so it lends itself nicely to a themed custom paint job. Another bonus is that it takes very little time to set up. Just remove four screws on the bottom cover, snap in your RAM, remove the SSD tray, install the SSD in the tray, put the tray back, and close her up. You're done.

Unfortunately, the integrated graphics didn't play nicely with our shaders, causing the game to crash whenever one was loaded, but we had no trouble with resource packs or the Optifine mod. Considering the performance hit that shaders caused with our beefier systems, the game probably would have chugged anyway. There's also a little fan inside the Brix Pro, but it didn't spin up very much during our sessions, and the unit never got hot. However, if you stress all four cores with video encoding or other highly multi-threaded activities, you'll hear it from a few feet away. All in all, we were pretty happy with the results we got.

You can build a solid entry-level gaming PC for this kind of money, so the Brix Pro is not the best option for raw performance or upgradeability. But if you want something super compact and portable, this is your ticket. In fact, we gave this one away to a lucky reader who entered a competition back in October last year. Case artist Jim Sailing of Smooth Creations gave the PC its luxurious Creeper look.

INGREDIENTS

	Part	Price
Case	Gigabyte GB-BXi5-4570R	$470
PSU	Bundled	N/A
Mobo	Integrated	N/A
CPU	Intel Core i5-4570R (soldered in)	N/A
Cooler	Integrated	N/A
GPU	Intel Iris Pro 5200 (integrated)	N/A
RAM	2x4GB Corsair DDR3/1600 SODIMM	$86
SSD	240GB SanDisk Extreme II	$130
OS	Windows 8.1 64-bit OEM	$100
Total		$786

> "Set up is quick. Just remove four screws, snap in your RAM, install the SSD, and close her up. You're done."

THE DYNAMITE BUILD

IT WILL BLOW YOU AWAY

When we used Cooler Master's Elite 130 case for a "Build It" feature in *Maximum PC*'s February issue, we thought it wasn't possible to make a case any smaller and still cram in a full system. Then the company sent us its Elite 110, which is about half as long.

While it's true that your options are more limited, we discovered it's still possible to make some sparks fly. The breakthrough is thanks in large part to vendors such as Zotac, Asus, and MSI, who've figured out how to miniaturize Nvidia's GeForce GTX 760 video card, which has a very good price-performance ratio at around $250.

The Elite 110 comes with one 120mm intake fan and can mount two 80mm fans on the side.

GET OUT MY GRILL

Zotac's result is slightly longer than the other two and needs two PCI Express power cables instead of one, but we still end up with a little room to spare, and the case actually takes full-sized power supplies. Our friends at Smooth Creations painted it to look like a TNT block from *Minecraft*. Unfortunately, painting the front grill simply isn't practical, as the case needs that opening to create airflow for all the hard-working gear crammed inside. Because of the way the power supply is situated, you can't put a big cooler on the CPU. But a locked Intel Core i5 CPU is still a very good chip to have running things.

The Gigabyte GA-H97N-WIFI Mini-ITX motherboard will take 16GB, but 8GB was fine for our needs. While our CPU and RAM are basically equal to the Brix Pro, this case can take four 2.5-inch drives and has a mount for a 3.5-inch drive. Add the video card, and you're on a whole new level of performance.

At 1080p with a 64x64 texture pack, the Optifine mod, and SEUS shaders, our Intel Core i5-4430 and GTX 760 kept us in the 40–50fps range. Without the shaders, frame rates averaged around 200. At Ultra HD resolutions, we still consistently hit over 60fps, as long as we didn't load a shader. That would knock the fps down to 15–20.

This is roughly the level of performance we expected. It would be nice to hit the 60fps mark at 1080p, but to achieve that it looks like we'd need to go up a notch on the video card, and maybe overclock the CPU.

INGREDIENTS

	Part	Price
Case	Cooler Master Elite 110	$50
PSU	Cooler Master V550 550w	$80
Mobo	Gigabyte GA-H97N-WIFI	$100
CPU	Intel Core i5-4430	$180
Cooler	Integrated	N/A
GPU	Zotac GeForce GTX 760 2GB AMP! Edition	£240
RAM	2x4GB Corsair DDR3/1600	$86
HDD	1TB Seagate Barracuda	$55
SSD	240GB SanDisk Extreme II	$130
OS	Windows 8.1 64-bit OEM	$100
Total		$1021

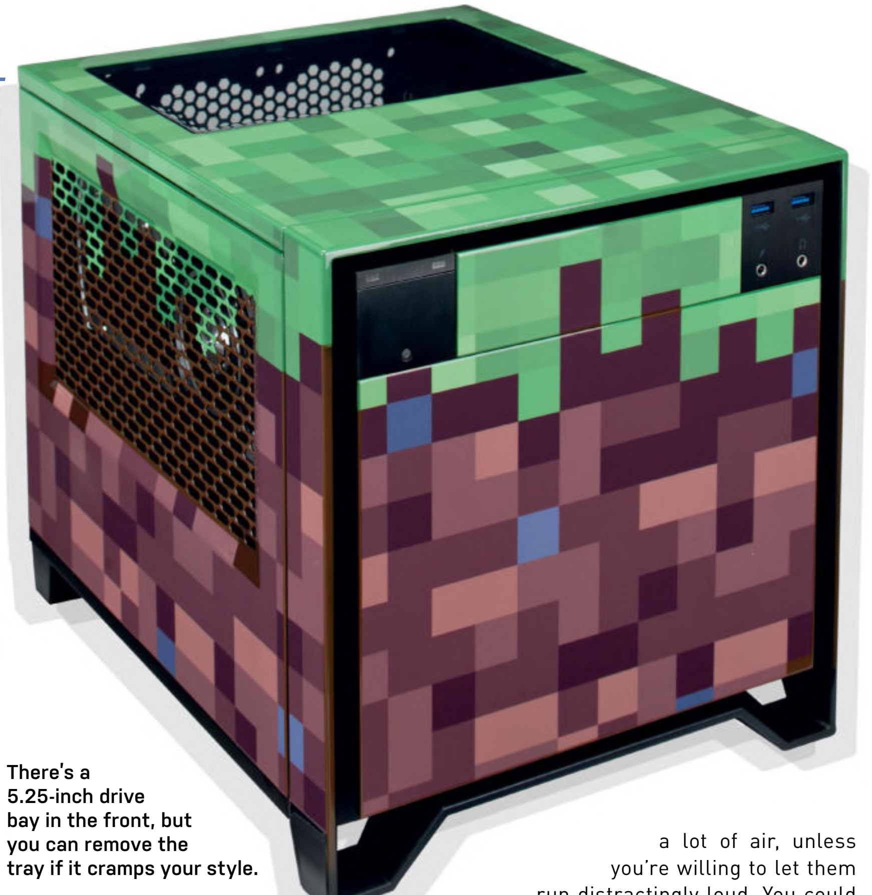
> "Without the shaders, frame rates averaged around 200. At Ultra HD resolutions, we still hit over 60fps."

DON'T WALK ON THE GRASS

IT'S ARMED AND FULLY OPERATIONAL

Playing with itsy-bitsy computers is fun and all, but enthusiasts like us will always yearn for a little more power. Well, the Corsair Obsidian 250D case puts few restrictions on the size of your video card or power supply, accommodates a 240mm radiator, and even has a window on the top so you can peek inside. Bingo!

We gathered our own team of super heroes: A GeForce GTX 780 Ti, Intel Core i7-4770K, Asus ROG motherboard, Enermax Liqtech 240 cooler, and a Seasonic G-series power supply. This is very similar to September's "Build It" rig. A key difference is the motherboard. We actually went back a step to Intel's older Z87 chipset. That's because, as this issue went to press, there was no high-end mini-ITX Z97 motherboard, and we wanted to ensure a high overclock, since *Minecraft* does respond to higher CPU clock speeds (though we received the Maximus VII Impact after we finished our build). We'd need all the clocks we could get after fully tweaking *Minecraft*'s visuals, as those shaders do a number on your frame rate.



There's a 5.25-inch drive bay in the front, but you can remove the tray if it cramps your style.

INGREDIENTS

	Part	Price
Case	Corsair Obsidian Series 250D	$85
PSU	SeaSonic G Series SSR-550RM 550w	$80
Mobo	Asus Maximus VI Impact Z87	$230
CPU	Intel Core i7-4770K	$340
Cooler	Enermax Liqtech 240	$110
GPU	EVGA GeForce GTX 780 Ti 3GB 03G-P4-2881-KR	$680
RAM	2x8GB Corsair Vengeance Pro DDR3/1866	$185
HDD	Seagate Barracuda 3TB	$100
SSD	500GB Samsung 840 Evo	$250
OS	Windows 8.1 64-bit OEM	$100
Total		$2160

KEEPING OUR COOL

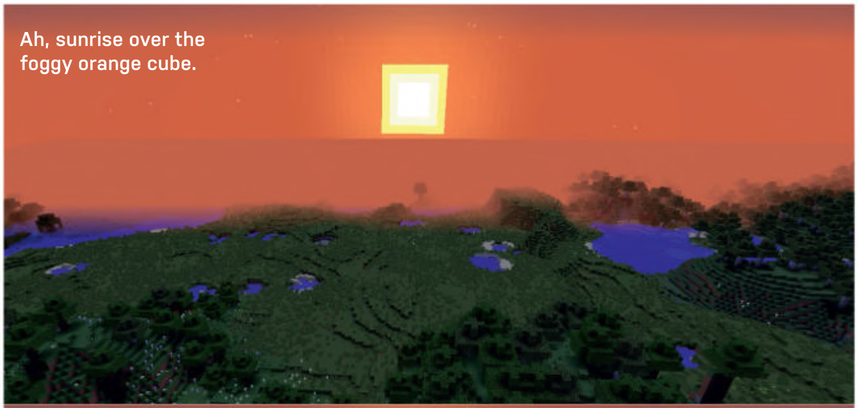
We could have gone with a Radeon R9 290 or 290X, which both perform in the neighborhood of a 780 Ti for less money, but we wanted a video card whose cooling design would vent most of the GPU's heat out the back of the case. That meant using the stock cooler, and Nvidia's run much quieter and cooler in this department than the stock R9 cards. It's true the Corsair 250D has two 80mm fan mounts in the rear, just above where the motherboard goes, but fans of that size just don't move a lot of air, unless you're willing to let them run distractingly loud. You could also use an air cooler on the CPU and put two 120mm case fans where the radiator would go, but you can get a higher CPU overclock with a 240mm liquid cooler.

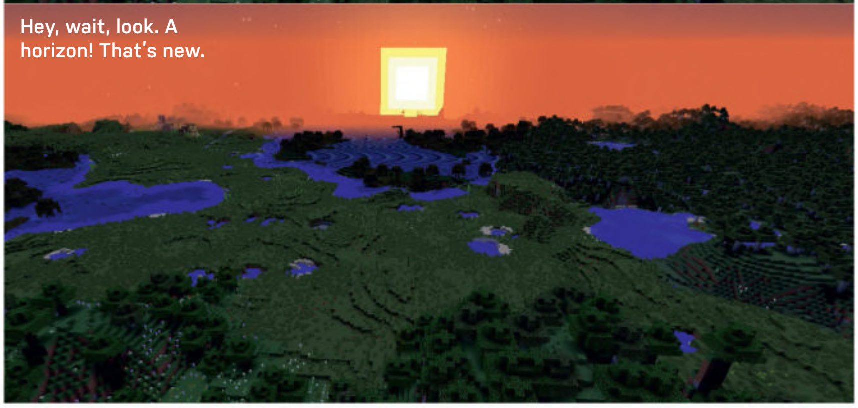
Speaking of which, the eight-threaded Core i7-4770K is probably total overkill, since *Minecraft* uses just a couple of cores. We probably could have gotten away with using that 20th Anniversary Pentium CPU, which we've overclocked to 4.7GHz. On the other hand, the plethora of threads in our 4770K lets us do a much wider variety of things, such as encode a video in the background, or watch a 1080p movie on another monitor. It's very fancy.

Since this system stayed reliably above 60fps at 1080p with shaders loaded, there

DOUBLE UP WITH OPTIFINE

Even at its maximum, vanilla *Minecraft* can only load 16 chunks (world-high columns of 16x16 blocks) in all directions away from the camera, and your redstone contraptions will seize up if their chunk isn't loaded. Install Optifine and you can put your multi-core CPU and all that RAM to good use, doubling the chunks *Minecraft* can render at one time while keeping your frame rate slick. That's over a square kilometre of the world—and the redstone within it—loaded at any one time. **–AC**


Ah, sunrise over the foggy orange cube.


Hey, wait, look. A horizon! That's new.

wasn't much to tweak, or so it seemed. At 4K, we hovered around 35fps, but we could push it to 40 after overclocking to 4.5GHz on all cores. However, we dug around again for other shader packs, and this time we stumbled on one called "CUDA Shaders." It doesn't actually use Nvidia's CUDA technology, and it's not as pretty as SEUS to our eyes, but it's still much neater looking than the vanilla game, and it let us maintain 60fps even at Ultra HD resolution. We picked it up on the creator's website, http://dedelner.de.tl. You may actually prefer it over SEUS, so it's definitely worth a look.

THE LEARNING CURVE

Of these three builds, it's the GTX 760 that we actually had the most fun with. The Cooler Master Elite 110 is a neat little case and fits an impressive amount of stuff. It actually has more storage-device mounting points than the much larger Corsair 250D. And not putting a top-end GPU in the box forced us to get under the hood with graphical settings and figure out what was going on, so we learned more about the game and about GPU behavior than we would have otherwise. And as they say, knowing is half the battle.

THE PAINTER

Much of the magic with our three ultimate *Minecraft* builds isn't necessarily the parts inside, it's what's on the outside. The exquisite paint jobs turned otherwise sedate cubes into real-life representations of *Minecraft*. When it came to getting it done, we turned to none other than the Michelangelo of case painting: Jim Sailing at Smooth Creations. We've featured Jim's work in *Maximum PC* before—he's painted numerous Dream Machines for us over the years—so we knew he was capable of shooting our *Minecraft* builds systems.

What we didn't expect, though, were the spectacular results. It may be a little hard to tell from our photographs, but these *Minecraft* machines are gorgeous. Besides the 8-bit aesthetic that transforms our rigs, Smooth Creations hit each box with multiple layers of clear coat to give them a paint job that's easily smoother than the one on your car. But Jim "Smooth" Sailing doesn't just shoot PC cases though—his company will beautify laptops, game consoles, and even guitars.

The cost of having a case painted isn't as crazy as you might think. Smooth Creations apply custom paint or hydro-dipped exteriors for $200 to $400, depending on the complexity of the job—Smooth Creations has to sometimes tear a case down to its base components in order to paint it properly. Visit www.smoothcreationsonline.com for more information. **–GU**

> "The plethora of threads in our 4770K lets us do a much wider variety of things. It's very fancy."

BUILD IT

TOM MCNAMARA **TECHNICAL EDITOR**

Windows 10: Let's Get Ready

Fitting multiple radiators into a new mid-tower case from Fractal Design, ready for Windows 10

LENGTH OF TIME: **1–3 HOURS**

LEVEL OF DIFFICULTY: **MEDIUM**

THE MISSION

JUST LIKE WINTER in Westeros, Windows 10 is coming, and with it comes DirectX 12, which introduces the next version of Direct3D, the graphics API at its heart. A great benefit of DirectX 12 is that it is going to reduce your GPU load, so you should get more from your existing graphics card. With this in mind we've decided to create a gaming system that would suit Windows 10, so we've gone for a AMD Radeon R9 295X2, a decent card that should run well in the new OS.

In this build we do something relatively straightforward that also has an eye on Windows 10: a nice gaming system that doesn't break the bank, built inside a relatively conventional mid-tower case. But there's some new and interesting hardware in the mix, of course—expect nothing less. We have minty-fresh gear from Fractal Design, Corsair, and Asus for your perusal. This build is also oriented toward low noise, so those of you with sensitive ears might want to check it out.

NOT LOUD, STILL PROUD

WHEN YOU'RE TRYING to cut down on noise generation, the biggest factor is your case. Fractal Design recently released the Define R5, which is a mid-tower with pre-installed noise absorption panels on the sides and front. The top of it uses the company's "ModuVent" system, which features modular panels with their own sound absorption that you can pop out to mount fans. We've had great success in the noise department with the R4, and this line of cases is quite roomy and sturdily built as well. Perfect for our needs.

The funky-looking videocard in there is the Radeon R9 295X2. This has two 290X GPUs in it, and an integrated water-cooling system with a 120mm radiator and fan. We moved some things around to make room for its cooling. Since it only costs around $650, despite being the fastest single card available (Nvidia's Titan Z was apparently a limited run), it seemed like a no-brainer.

Of course, he needs some hefty power, so we're adding our trusty 800W Cooler Master Silent Pro Gold. This—along with an Intel Core i7-4790K, 2x 4GB of low-profile Corsair DDR3 RAM, a 480GB SanDisk Extreme II SSD, and a 4TB WD Black Edition—gets plugged into an Asus Z97 Pro Gamer motherboard, which we should be able to overclock respectably. We've also added a 120mm Noctua fan to the front of the case. Otherwise, we'd have just the one 140mm pre-installed fan in that spot.

INGREDIENTS

PART		PRICE
Case	Fractal Design Define R5	$110
PSU	Cooler Master Silent Pro Gold 800W	$130
Mobo	Asus Z97 Pro Gamer	$160
CPU	Intel Core i7-4790K 4GHz	$340
GPU	AMD Radeon R9 295X2	$650
RAM	2x 4GB low-profile Corsair DDR3	$60
SSD	SanDisk Extreme II 480GB	$440
HDD	Western Digital Black 4TB	$213
OS	Windows 8.1 64-bit OEM	$100
Total		$2,203

1

PANEL BEATING

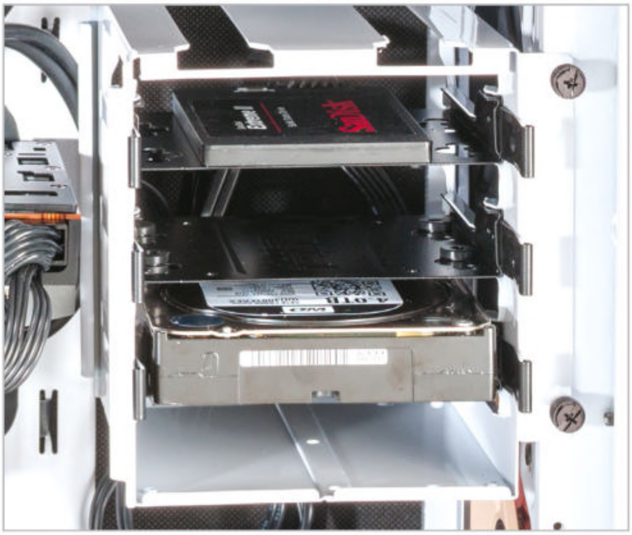
THIS SWITCH IS NEW to Fractal Design cases. When you press down, it releases two catches that hold the side panel onto the case. That means you have toolless entry with just a flick. You can optionally add two screws if you're worried that the panel will pop out when you're not looking. Under ordinary circumstances, however, it's not possible to get in without pushing down on this widget. Unfortunately, it's a bit tricky to get the side panel back on, so this might not be the best case for first-time gearheads. The sound-absorption layer adds weight, so you need to grip the panel firmly on removal, to avoid gouging your desk.

2

HARD CASE

THIS CASE actually comes with three drive cages with a total of 10 drive trays. All cages are removable, even the 5.25-inch cage at the top. We kept only the smaller 3.5-inch drive cage and lifted it to a higher mounting point to make room for the videocard's radiator down below. We could have tossed all the drive cages, because there are two 2.5-inch mounts behind the motherboard, but then there would be nowhere to install the WD drive.

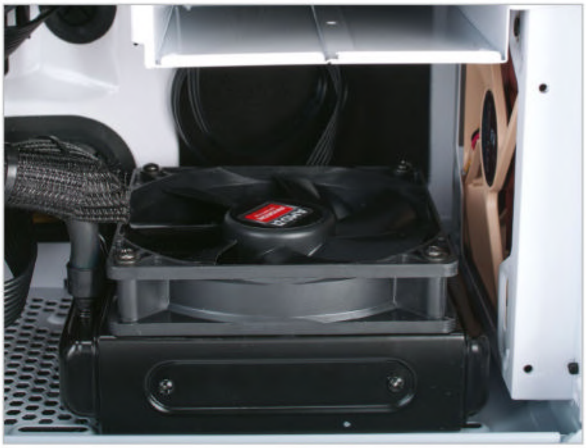
The case comes with silicone grommets that you can slide into a drive tray to absorb the vibration of a mechanical drive, and each tray can take a 2.5-inch drive as well. All of the trays are metal (which is rare), so you don't have to worry about snapping bits off through rough handling or dropping on the floor. And because this case is so wide, you don't need right-angle cables in the back.



3

SCREAMING FANS

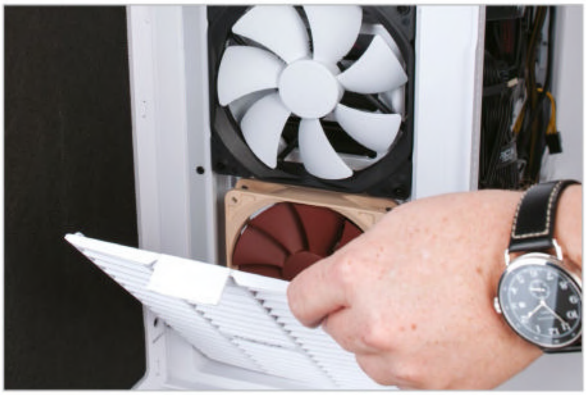
WITH THE DRIVE CAGE elevated several inches, we have enough clearance to install the videocard's radiator. The rad gets screwed in from below, after sliding out the dust filter underneath the case to make way for installation. We had some concern that the air coming from the case's front intake fan would get sucked into the rad's fan, which would mean less airflow across the motherboard, so we added a 120mm Noctua fan in front to provide more cooling. We also could have removed the ModuVent on the side to install a case fan there, but that would increase the noise level.



4

ACCESS ALL AREAS

THE LARGER FAN in the top of this image is 140mm and comes pre-installed. You can lift the dust filter away to access the whole front area. There are notches on the right of the fan mounts to feed their cables back into the case. At that point, you can connect them to the case's integrated three-speed fan controller, or plug them into mobo fan headers, if available. We opted for the controller. It gets juice from your power supply via a SATA power connector. You may have noticed there are no grills on the front. Instead, the R5 has vents on the sides to pull in air. This way, it can dedicate the front to a slab of noise-absorbing material. It's pretty slick. If you don't care about that, you can remove the door. It's just attached with a couple of screws.



5

WIDE LOAD

FROM ABOVE, you can see just how wide this case is. Those black screws are attached to a standard 240mm radiator (that of the H100i GTX that's cooling our CPU). Why would you want to shift everything to one side? That way, you don't have to worry about large mobo heatsinks or tall RAM sticks blocking the installation of a radiator and its fans. There's plenty of room to now add a second set of fans to the rad, which is pretty rare for a mid-tower. And there's room for a 360mm rad if you remove the 5.25-inch drive cage.

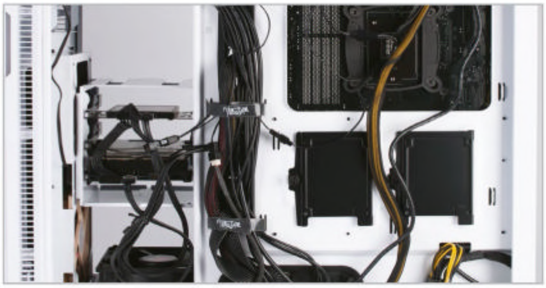
We installed the fans below the rad, pushing its heat out of the case. This is much easier than trying to sandwich the fans between the rad and the top of the case in a "pull" formation. Some cases have extra-wide mounting holes designed for case fan screws, but Fractal Design seems to understand that this location is more likely to be used for installing a radiator, so we had no issues there.

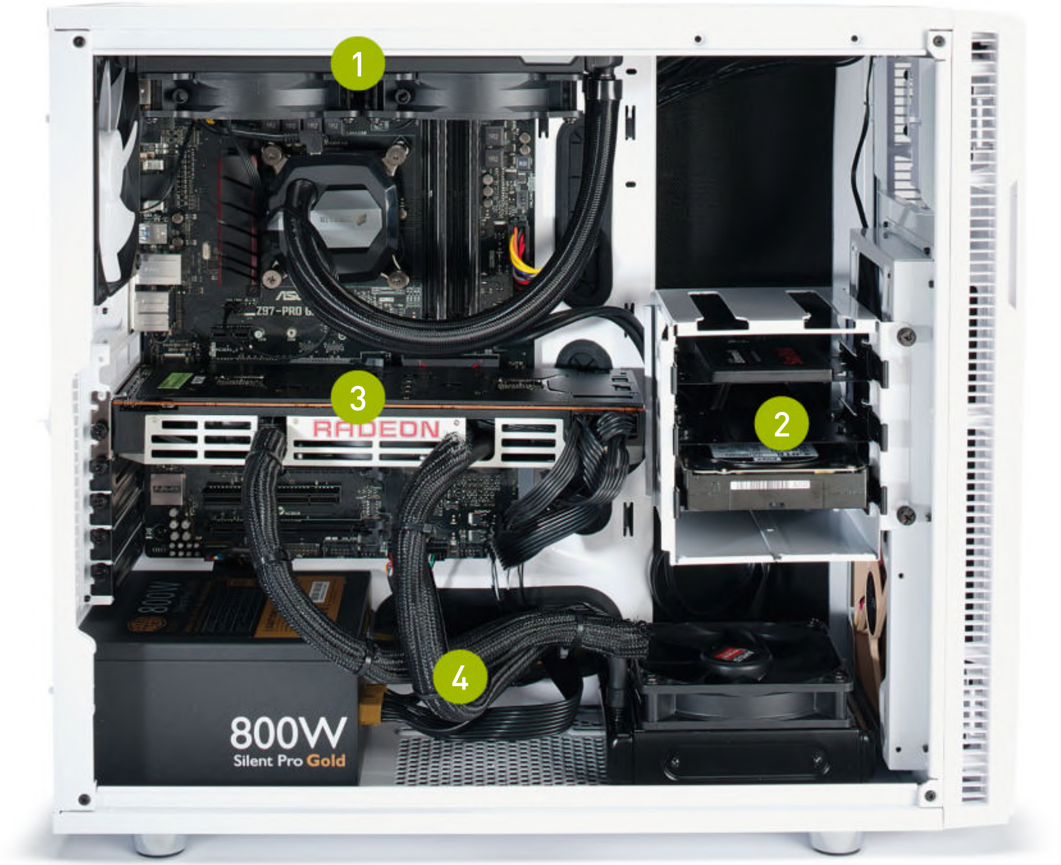
6

NICE AND TIDY

WE COULD TAKE CREDIT for the cleanliness, but it turns out Fractal pre-routed the cables coming in from the front (things like two USB 2.0 ports, two USB 3.0 ports, headphones, and mic) and strapped them down with these Velcro straps. We just had to take their lead, loosening the straps to make room for a 24-pin power cable.

The mobo tray is sunken compared to the R4, so there's less play behind it. That gives you the radiator clearance we talked about, and also allows taller air coolers. We can still send a rounded 8-pin CPU cable back here without contortions. You'll note a similar-looking cable down below. This is for PCIe power. It's integrated into the power supply, so we can't remove it. We went with two modular cables because they were flat (and so more flexible) plus all-black (making them less noticeable). We hooked up the fan controller and two drives with a single SATA cable.





1 The top of the case can take a 280mm radiator, but only if it's mounted toward the front, since the screw holes are too close to the rear.

2 We put grommets in the drive tray that we didn't use, in case we wanted to add a hard drive later and couldn't find the little bag that holds these widgets.

3 Despite this videocard being about 12 inches long, there's still plenty of clearance between it and the drive cage.

4 We used this 295X2 in the Dream Machine last year, which is why it has the sleeved tubing. The "stock" version has bare tubes.

ROCKET RIG

OVERALL, this system felt like a solid gaming machine. We got an average of 145 frames per second in *Batman: Arkham City*, with all settings cranked up at 2560x1600 (other than Nvidia's proprietary PhysX). When running the videocard benchmarks, the 295X2's radiator pumped out a lot of heat through the bottom of the case, as expected, but the lower intake fan on the front of the case recirculated a minimal amount of that, thankfully. The best orientation for the rad would probably be on the top of the case or the side, if possible, since heat rises. But the bottom mount seems to do well in a pinch. And our 800-watt power supply had no trouble dealing with the hefty power requirements of this videocard.

Corsair's H100i GTX performed admirably, its fans hardly spinning up no matter what load we put on the CPU, which was overclocked from 4GHz to 4.4GHz and didn't go past 73 degrees Celsius. We probably could have pushed it to 4.5GHz, but we prefer being confident about the stability of the system versus cranking it up as hard as we can and quickly running a test before the thing locks up. That can be fun, but it's not representative. And with this radiator, the chamber on the side that connects to the tubes was a little wider than we anticipated, and the case's rear exhaust fan obstructed it. That's why the tubes are coming out on the "far" end, with the pump logo upside-down.

A fresh system is also super-snappy, allowing a full reboot cycle in less than 20 seconds. So you can get into the BIOS, make a tweak, and be back to Windows in a flash. The motherboard initially wouldn't let us boot at all, because we didn't have anything plugged into the CPU fan header (the cooler's fans plug directly into the pump). We had to hunt around before we found the setting to ignore that header altogether, but it's an important safety measure to have. By default, a system will shut down if the CPU gets too hot, but you can override that—at which point you better have everything plugged in correctly.

Despite its rocket-fueled performance, this system is a bit slower than our zero point in some tests, even with its higher clock speed. That's because the i7-3930K has two additional cores—and an MSRP of about $580. At about $340, the 4790K is not bad value.

BENCHMARKS

	ZERO-POINT	
Premiere Pro CS6 (sec)	2,000	2,327 (-16.4%)
Stitch.Efx 2.0 (sec)	831	766 (8.5%)
ProShow Producer 5.0 (sec)	1,446	1,270 (13.9%)
x264 HD 5.0 (fps)	21.1	19 (-11%)
Batman: Arkham City (fps)	76	145 (91%)
3DMark 11 Extreme	5,847	7,883 (34.8%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100% 110%

Our current zero-point consists of a hexa-core 3.2GHz Core i7-3930K (turbo 3.8GHz), 16GB of Corsair DDR3/1600, on an Asus Sabertooth X79 motherboard. We are running a GeForce GTX 690, an OCZ Vertex 3 SSD, and 64-bit Windows 7 Professional.

BUILD IT

TOM MCNAMARA **TECHNICAL EDITOR**

Double Trouble: X Marks the Spot

Dual Nvidia Titan X cards await within this treasure chest

LENGTH OF TIME: **1–3 HOURS** LEVEL OF DIFFICULTY: **MEDIUM**

THE MISSION

OVER THE PAST SIX MONTHS or so, we've seen an impressive new slate of hardware arrive on store shelves, from Intel's Haswell-E generation of workstation CPUs sporting 6–8 cores, to futuristic-looking cases from Corsair, to the return of Nvidia's flagship GPU in the guise of the GeForce GTX Titan X.

We decided it was high time to bring this all together, while also checking out the viability of an older power supply and a new closed-loop liquid CPU cooler from Silverstone. To a degree, this is an "out with the old, in with the new" kind of build, where we bid farewell to a venerable piece of gear that's been eclipsed, while embracing the future of enthusiast gear.

We usually build with parts that have been released roughly within the past year, but not everyone is so fortunate. And sometimes you have equipment that's a little long in the tooth but still works fine. Might as well integrate it into a new build, right? And as we learned, the "old" stuff can still scale to handle cutting-edge gear, though the margin can get pretty thin.

GEFORCE GTX
GEFORCE GTX
CORSAIR

HERE BE DRAGONS

AS MUCH AS WE LIKE the portable form factor of a Mini-ITX case, a full-tower like the Corsair Graphite 780T is more forgiving. It also looks pretty cool. Since our power supply uses rounded cables, we need a little more leeway than usual for cable management (most vendors are moving to flat cables, which take up less space). Our PSU is the well-regarded Silverstone Strider Gold, which came out about three years ago. This 1,200-watt version can supply up to eight PCI Express cables, so it's pretty expandable. The unit is also relatively compact, with a length of only 7 inches. For reference, the Corsair AX1200 is 8 inches long. Compactness has long been a hallmark of Silverstone PSUs, and it's something we've often relied on.

We've paired our videocards with the Intel Core i7-5820K. This one has six CPU cores. It's slotted into an Asus X99-A/USB 3.1 motherboard. As its name implies, it has integrated USB 3.1 ports, and it can do NVM Express as well. Last but not least is the 240mm Silverstone TD02-E closed-loop CPU cooler, which is a recent update of the original TD02. Also in the mix is a 1TB 840 EVO we wanted to give one last run, and 16GB of 2,800MHz Corsair Vengeance low-profile DDR4. We opted to not put a hard drive in this particular system, since we almost never use them in Build It.

INGREDIENTS

PART		PRICE
Case	Corsair Graphite 780T	$176
PSU	Silverstone Strider Gold 1,200W	$300
Mobo	Asus X99-A/USB3.1	$280
CPU	Intel Core i7-5820K	$380
GPU	2x Nvidia GeForce GTX Titan X	$2,000
RAM	4x 8GB Corsair Vengeance DDR4	$660
SSD	1TB Samsung 840 EVO	$440
OS	Windows 8.1 64-bit OEM	$100
Total		$4,336

1

THAR SHE BLOWS

WE'VE COME TO ENJOY these handy fan grills that pop out really easily when you give the top corners a simple click. Once you've experienced them it's hard to go back to the days of wrenching off the front of a case in order to access fan mounts and drive bays. Behind this grill, we then discover two pre-installed 140mm intake fans, which glow bluish-white when powered up. You've also got the option to mount three 120mm fans, or one 200mm fan.

If you remove the drive cages found just behind these fans, you can also install a variety of radiators, all the way up to 360mm. The cages are just screwed in—there's no need to reach for the hacksaw. These fans can plug into the case's integrated fan controller, which we'll talk about further on.

2

BATTEN YOUR HATCHES

THE 780T ALSO HAS A CLICKY GRILL on the top. Below is a recessed set of fan mounts, so you can put fans up here without obstructing things inside the case proper. This spot will take three 120mm fans, or two 140mm fans. If you have a 25mm radiator, there's enough space for "push-pull," which puts fans on both sides of the rad.

We installed the Silverstone cooler's fans below the rad, to reduce noise. This required mounting the rad with some longer screws than those provided, because the 780T's mounting holes are padded with rubber grommets whose thickness adds another 3mm or so. Luckily, you can get inexpensive machine screws in a variety of lengths from a home improvement store. Take the shorties to act as visual aid.

3

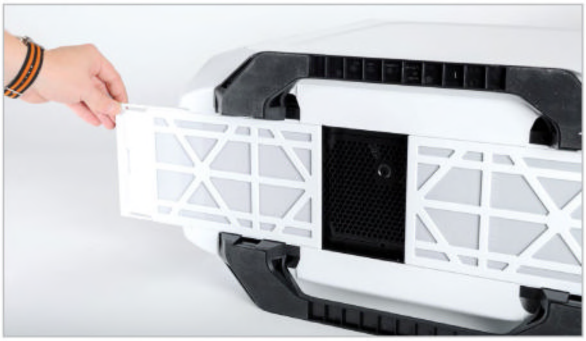
CHECK YOUR RIGGING

THE 780T'S INTEGRATED fan controller has four connectors (three shown here, because we're using three case fans), and they're all within easy reach of the case's pre-installed fans. Sometimes the rear exhaust fan's cable isn't long enough, but that wasn't a problem here. The controller itself is powered via a SATA cable, so make sure you have an extra when building with this case. It has three speeds, but these fans didn't get loud even when maxed out. The controller is handy because it frees up your motherboard's connectors for additional fans. We also note the connectors here are industry-standard 4-pins, instead of being proprietary.

4

ANCHORS AWEIGH

AS HAS BECOME COMMON on the high end, the 780T's undercarriage has some niceties, as well. Down here, we have not one but two dust filters that can slide out for easy cleaning or replacement. Observant readers may also note the fan mounting holes peeking out. The bottom of the case has one 120mm fan mount that's immediately accessible, and another 120mm when you remove the lower drive cage, which means you have space for a 240mm radiator. That's useful for a water-cooling loop attached to a videocard. This case has some impressive airflow potential. The black ABS plastic feet on either side of these filters elevates the case about one inch off the floor, giving your power supply's intake fan plenty of clearance to get cool external air. Each corner of the feet is also rubberized for stability.

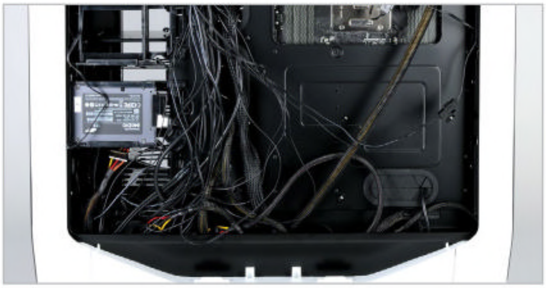


5

THE POOP DECK

NOT THE CLEANEST WIRING JOB we've ever done, but that was kind of the point. We wanted to demonstrate how messy things could get, while still allowing the side panel to go on without any effort. We've six rounded power supply cables coming through, a SATA data cable, three fan cables, a variety of front panel cables, and even cables from the CPU cooler mounted in the top of the case, which we tucked back here just to make things look nice and clean up front.

The Strider Gold's 24-pin motherboard cable was just barely long enough, but we had no trouble with the 8-pin power cable that went to the upper right-hand corner. The SATA power cable had to terminate at a 90-degree angle to fit into the back of the SSD, but that's not unusual. Once we were done back here, the toolless side panel just angles in at the bottom and snaps shut at the top. To remove it, just pull the handle and lift it away.

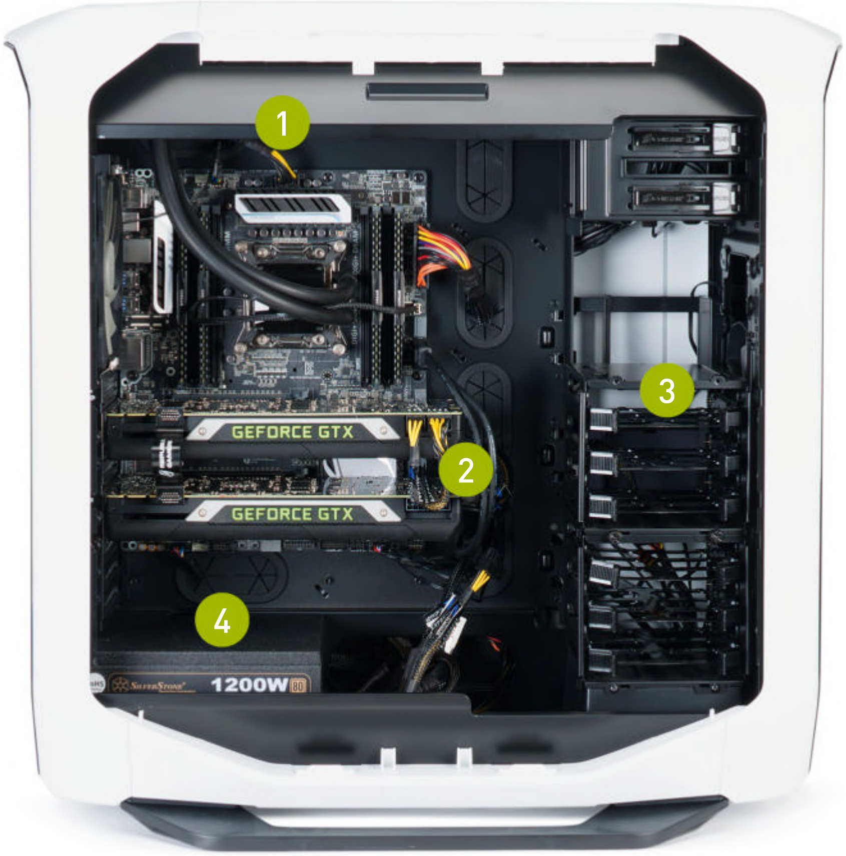


6

IN THE CROW'S NEST

IN CASE YOU HAVEN'T SEEN how the 2.5-inch drive trays work, here's a close-up. It's another toolless container, where you just slide the drive in from the side. The tab at the bottom snaps in when the drive has slid all the way to the left. The installation of the tray is also toolless. There's a bracket mechanism on the other side of this tray that snaps in. It can be a little tricky to put it back in once you've taken it out. We recommend a flashlight and some patience.

There are usually four of these trays in the back, but we removed the bottom-most one to make room for our cabling shenanigans. Admittedly, these trays are not snug. That's fine for an SSD, which has no moving parts. If you're using a 2.5-inch mechanical drive, the top of the tray has two screw holes to create a tighter fit. Whichever type of drive you choose, we recommend a flat SATA data cable if you need to face the drive outward like we did.



① Thanks to the height of this case, the radiator and fan disappear completely inside this upper shroud.

② With one PCIe cable removed, you can more clearly see that we're only using two of them, thanks to this cable design.

③ We left the drive cages in so that you could visualize how much space a 10.5-inch card takes up. The 780T is deceptively large.

④ Based on its size, you wouldn't think that this PSU could put out 1,200 watts. But Silverstone is known for compact designs.

LAND HO!

YOU MAY HAVE HEARD that the Intel Core i7-5820K has fewer PCI Express lanes than the other Haswell-E CPUs, and that's true. But 28 lanes is still more than two videocards know what to do with, so we don't need to bump up to the 5930K, which would also cost us another couple of hundred dollars. Of course, we're already blowing two grand on our videocards, but we had multiple reasons for that. Besides having top-end performance, these cards also draw a healthy amount of power. We're also overclocking our hex-core CPU from a base clock of 3.3GHz to 4.2GHz, on all cores. And there are five case fans in this system. This combination of parts gives us a solid testing environment to see how this 3-year-old power supply still handles itself. Like we were hoping, it didn't break a sweat, and its fan made hardly any noise.

Sadly, this PSU can't be a mainstay any longer, because its PCI Express cables have a total of "only" four 8-pin connectors. Reference versions of a card like the Nvidia GeForce GTX 980 use two 6-pin connectors and seem to signal lower requirements than we've seen before; vendors can produce cards like the MSI Gaming 4G, which requires two 8-pin connectors. This PSU's combined PCIe cabling is nice, though. Each has both an 8-pin and a 6-pin connector. So if the card doesn't need more cables than that, you only need one per card. That helps with cable management and makes the case interior look cleaner.

The company's TD02-E closed-loop CPU cooler, meanwhile, came out earlier this year. Despite having to cool six Haswell-E cores running 900MHz faster than their base clock, our temps never got above 72 degrees Celsius. You could definitely hear the fans working to keep things cool, but it was never distracting. Part of this is thanks to the radiator's dense fin array, and that requires fans capable of moving a lot of air, but Silverstone is no slouch in the fan department either. The two bundled units are rated to move up to 92.5 cubic feet per minute. For reference, the Corsair H100i is rated to move up to 77 CFM. For an 8-core CPU, we'd still recommend at least the H110i GT, if not custom water cooling. But the TD02-E did impressively well with our respectably overclocked i7-5820K. Overall, we enjoyed building this rig and finding out what this gear was capable of. ⏻

BENCHMARKS

	ZERO-POINT	
Premiere Pro CS6 (sec)	2,000	1,571 (27%)
Stitch.Efx 2.0 (sec)	831	749 (11%)
ProShow Producer 5.0 (sec)	1,446	1,384 (5%)
x264 HD 5.0 (fps)	21.1	26.9 (28%)
Batman: Arkham City (fps)	76	206 (271%)
3DMark 11 Extreme	5,847	13,034 (223%)
		0% 25% 50% 75% 100% 125% 150% 175% 200% 225% 250% 275%

Our current zero-point consists of a hexa-core 3.2GHz Core i7-3930K 3.8GHz, 8GB of Corsair DDR3/1600, on an Asus Sabertooth X79 motherboard. We are running a GeForce GTX 690, an OCZ Vertex 3 SSD, and 64-bit Windows 7 Professional.

BUILD IT

TOM MCNAMARA **TECHNICAL EDITOR**

Creating A Quiet But Beastly PC

Low noise doesn't mean low joys

LENGTH OF TIME: **2–4 HOURS**

LEVEL OF DIFFICULTY: **MEDIUM**

THE MISSION

IN THE CREAKING depths of the secret *Maximum PC* lair, we're often found constructing compact PCs or just putting shiny new things together and seeing what they do. And that's usually pretty entertaining. But it occurred to us that it's been a good while since we tackled a quiet PC build. After all, as much as we like raw power, we don't want to hear that power all day long.

But that doesn't mean we need to sacrifice performance. If we create a whispery rig, we can still build it to growl and roar in its own way. And it's not as difficult as you might think. With the right case, CPU cooler, and videocard, everything can fall into place. Luckily, the hardware components market is chock-full of interesting possibilities, one of which was so new that it hadn't even been reviewed as this issue went to press. We entered this undiscovered territory, and we think it was worth the journey. This build didn't turn out quite the way we expected, but a little ingenuity made it come together in the end.

ARMED TO THE TEETH

THE MOST IMPORTANT ELEMENT of a quiet PC build is the case. You want to keep the racket down, and that means sound-absorbing panels. You can glue your own in, or you can buy cases with panels pre-installed. Last time, we used a Fractal Design Define R4, which is still a fine choice. But we needed something with more airflow (the R4 comes with only two fans). Enter the NZXT H440. We decided to go a step further and get the Razer edition, which is almost all black, save for a few neon-green details. It has three 120mm intake fans, a 140mm exhaust fan, and space for a large radiator up top. It fit the bill. The radiator belongs to the Corsair Hydro H110i GT. This has a 280mm rad, thick tubing, and some nice aesthetics.

The H110i will be cooling an Intel Core i7-5960X. Like we said, we're not holding back. This 8-core, 16-thread chip is a monster for things like video editing and virtual machines, and we can overclock it quite a bit with the H110i. This hefty CPU sits on an Asus X99 Pro motherboard, which is a premium, feature-packed job. Along for the ride is 32GB of Corsair Dominator DDR4, a 960GB OCZ Vector 180 SSD, a 6TB hard drive from HGST, an MSI R9 290X Lightning, and a Corsair AX1200i power supply. Ladies and gents, we do not mess around. Read on to see how this epic stack of gear comes together.

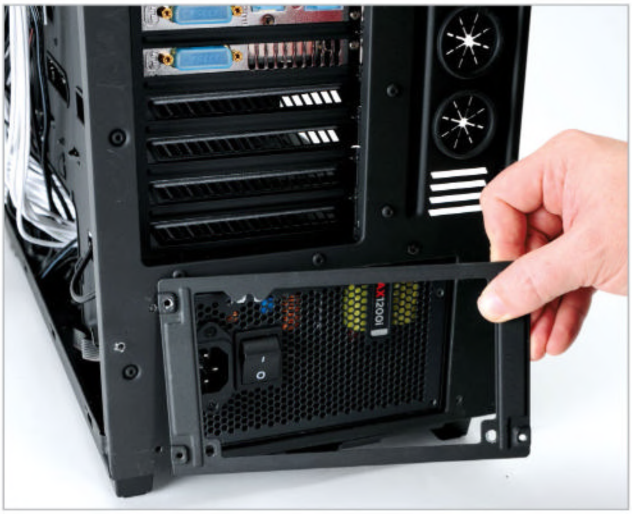
INGREDIENTS

PART		PRICE
Case	NZXT H440 (Razer edition)	$150
PSU	Corsair AX1200i 1,200W	$300
Cables	Optional Corsair Cable Kit (White)	$100
Mobo	Asus X99 Pro	$320
CPU	Intel Core i7-5960X	$1,050
GPU	MSI R9 290X Lightning	$333
RAM	4x 8GB Corsair Dominator DDR4	$660
HDD	6TB HGST UltraStar He6	$460
SSD	960GB OCZ Vector 180	$500
OS	Windows 8.1 64-bit OEM	$100
Total		$3,973

1 POWER BEHIND THE THRONE

THE POWER SUPPLY finds its cosy new home in a separate chamber at the bottom of the case, and it gets in there by sliding in gently through the back of the case, instead of coming in from the side as it usually would. To make that happen, you have to first remove this plate, which is held down by four thumbscrews. Then you slide your PSU in, put the plate back on, and screw the plate into the PSU.

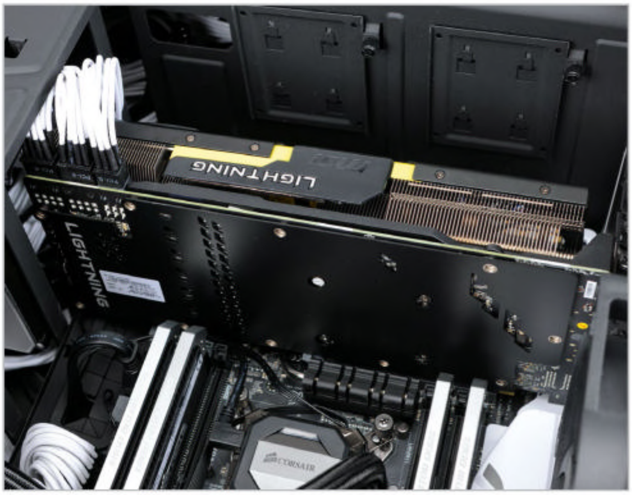
If you're using a modular power supply, like we are for this month's build, you also need to hang back and attach your cables before you get going with sliding the PSU in. That's because the back of the PSU will be difficult to reach past this point. It's a bit of pain, but that's always going to be one of the drawbacks of a clean-looking case.



2 GOING TO GREAT LENGTHS

INTERESTING HURDLES show up right away. We've put the mobo's I/O shield in, screwed the motherboard into the case, and installed our RAM sticks, when we notice the videocard is longer than expected. Thankfully, we can remove a drive tray in the front to make room.

It's attached with two thumbscrews and slides right out. But connecting the power cables is tight, even when you use these flexible ones. That's partly because this card is also taller than usual. If it used the reference height, then regular rounded cables would probably be fine. Also note this card uses an extra 6-pin cable. Our 8-pin cables come with two detachable pins, so we took the cable with the bonus pins and tucked it out of the way. There's a side window, so we want it looking tidy.



3

UNO, DOS, TRAYS

THERE ARE TWO TRAYS on top of the power supply compartment where we could have put our solid-state drive, but we like hiding it out of the way. You may have noticed by now that the H440 has no 5.25-inch drive bays. This cage has only 3.5-inch trays, which can also take 2.5-inch drives. After making room for the videocard and the CPU cooler, we had three trays left. We took the two that were closest to each other and used them for the SSD and the HDD. That allowed us to use one SATA power cable (which also connected to the CPU cooler). The drive attaches with a set of small bundled screws.

4

SOMETHING UP OUR SLEEVE

OUR FANCY INDIVIDUALLY SLEEVED CABLES came in handy behind the motherboard, because there wasn't as much space back there as we would have liked. The sound-absorption panel takes up a few millimeters in an already-challenging space. Thankfully, there was plenty of room in front of the power supply to tuck things out of the way, and we'd removed two drive trays for some more space. Since the drive cage in the front of the case is hidden by a large metal plate, we were able to use that to our advantage and obscure most of the mess.

We also made sure to install the 8-pin CPU power cable before installing the CPU cooler. Otherwise, the cooler's radiator and fans would have blocked our path. We also needed to whip out a Molex cable to power the hub that the case fans were connecting to. The fans themselves were hooked up to the hub at the factory, so that saved us some time and energy.

5

JOINING THE FAN CLUB

THE H440 CASE can take up to two 140mm fans on top, and up to three 120mm fans. But because of the contour of the frame, you can't set the radiator right against the metal. It's too tight. You have to put the fans in between the case and the radiator, which can be pretty tricky if you haven't tried it before. Getting the screws to line up correctly with the holes in the fans and the rad is a time-consuming process.

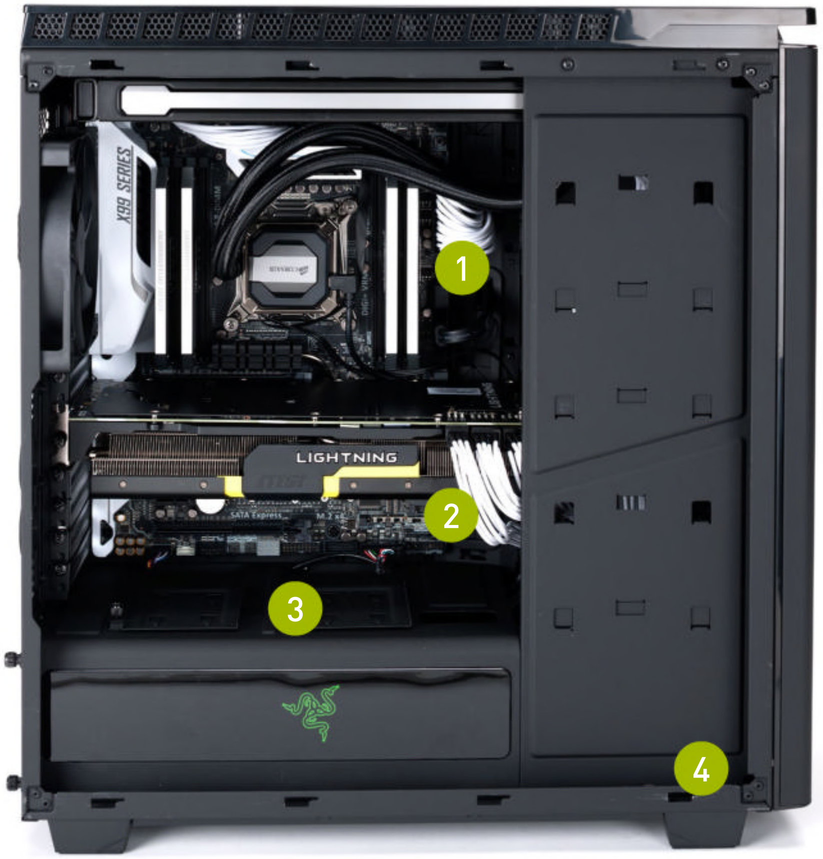
We have the fans facing upward so that they will pull the heat rising off the rad and send it out the vent in the panel that will sit on top of the case. The fans also need to be oriented so that their cables come out at the same location. This makes cable management much cleaner once the fans are hooked up to the cooler. You just tug the cables gently back behind the motherboard until you run out of slack.

6

TWO CAN PLAY THIS GAME

THE H440 HAD ROOM for pretty much everything we threw at it, but there wasn't space to add two more fans to the radiator. This is pretty normal for a mid-tower case. What we didn't expect is just how tight our fit would be. There's literally 1 to 2mm between the radiator and the mobo's rear I/O shroud. Because of this limitation, the radiator tubes had to be placed on the other end, and putting another set of fans on the cooler was out the window.

The side effect was that installing the CPU cooler with the Corsair logo right-side up was difficult to do in a way that looked natural. So we ended up with the logo upside-down. Not a big deal, and it has no impact on performance. We chalked it up to a learning experience. We've seen this case accommodate two extra radiator fans before—it's just not going to work with this particular motherboard.



1 The rubber grommet we're feeding the motherboard power cable through is at about a 30-degree angle, so your cable doesn't have to bend as much as usual.

2 For reference, this videocard is about 12 inches long and takes up three slots. It's a big mother. If you have a dual-slot card, there's still space to add a second one below.

3 This panel is a 2.5-inch drive tray held down by a thumbscrew. There are gaps behind it where cables can go in and out.

4 These feet elevate the case so that the power supply's intake fan gets enough clearance to do its thing. There's also a slide-out filter under here.

CONQUERING THE QUIET LIFE

AS WE'RE PREPARING THIS BUILD OCZ informed us it was pushing back the release date of its Vector 180 SSD, due to unspecified technical problems brought to its attention by people it had sent these units to for review. It was too late for us to re-build, re-benchmark, and re-photograph, so you'll have to visualize your favorite SSD in there instead. The good news is that SSD selection has a negligible impact on our set of benchmarks.

Speaking of performance, we were impressed by how easily the Asus X99 Pro overclocked this CPU. An OC from 3GHz to 4GHz at 1.3 volts is nothing to sneeze at, but this board needed no tweaking beyond our initial set of adjustments, which was mostly just beefing up the power sent through the voltage regulators. Not many programs use 16 CPU threads, which is why this chip wrecked our zero-point machine's stock-clocked hex-core i7-3930K in some tests, but not in others. The 5960X got into the low 80s Celsius during our Premiere Pro bench, indicating there wasn't much wiggle room left. You'd probably need a custom water cooling loop to push performance much further.

But let's not forget why we built this system to begin with: quietude. Well, plugging the fan hub directly into the power supply will create some noise, and there's no fan speed controller. And the CPU cooler's fans are also right underneath the top panel, instead of the radiator getting sandwiched in between. So the Fractal case we mentioned earlier still has some better options for noise level, and more space behind the mobo for cable routing.

Still, the case's stock fans aren't loud, and the sound-absorbing panels do muffle some noise, though the window on the side panel has an acoustic cost as well. If low noise is really important to you, we'd recommend the Define R4, though it needs at least one more fan for good airflow. The MSI Lightning card, with its monster three-fan, triple-slot cooler, hardly rose above a mild drone throughout testing, yet it still punched above its weight in *Batman: Arkham City*. The 290X is a great GPU that performs within range of an Nvidia GeForce GTX 980, but for less money.

Overall, we enjoyed wrangling this build into shape, and we were gratified to get solid, stable overclocks without needing hours of experimenting and fine-tuning.

BENCHMARKS

	ZERO-POINT	
Premiere Pro CS6 (sec)	2,000	1,263
Stitch.Efx 2.0 (sec)	831	753
ProShow Producer 5.0 (sec)	1,446	1,328
x264 HD 5.0 (fps)	21.1	31.8
Batman: Arkham City (fps)	76	91
3DMark 11 Extreme	5,847	5,005 -17%

0% 5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55%

Our current desktop test bed consists of a hexa-core 3.2GHz Core i7-3930K 3.8GHz, 8GB of Corsair DDR3/1600, on an Asus Sabertooth X79 motherboard. We are running a GeForce GTX 690, an OCZ Vertex 3 SSD, and 64-bit Win7 Pro.

BUILD IT

TOM MCNAMARA **TECHNICAL EDITOR**

Assembling the Perfect LAN Party Gaming Box

LENGTH OF TIME: **2–4 HOURS** LEVEL OF DIFFICULTY: **MEDIUM**

Get some meaty gaming muscle on the go with this portable powerhouse

THE MISSION

IN THIS BUILD we're going with Nvidia as the graphics card in favour of the Sapphire ITX Compact R9 285 we use on page 66. Our Asus GTX 970 DC Mini is at a higher tier of performance and also features twice as much VRAM. (You may have heard recently that the 970's VRAM is divided into two pools, with the smaller one performing more slowly, but it's only a few percentage points different.) AMD has the Radeon R9 290, which performs about the same as a 970, but it requires a lot more power, and there isn't one short enough to fit into an ITX case.

Generally speaking, these compact videocards have changed portable PC gaming a lot. Not all of the systems they go into are made equal, though, so we have to survey the landscape periodically to figure out what's hot and what's not.

LAN OF OPPORTUNITY

THE COOLER MASTER HAF STACKER CASE found on page 66 is a nice option for its modularity and low price, but we decided to go with a cube shape this time, instead of a shoebox. This makes the case easier to balance when it has an integrated handle, like we see on this Corsair Graphite 380T. Thanks to its larger dimensions in the front, the 380T can also fit a 200mm intake fan, though it ships with a 140mm unit in front (and a 120mm exhaust fan in back). You can also fit two 120mm fans on the side, or a 240mm radiator. We, of course, went with the radiator option, specifically the trusty Corsair Hydro H100i. We had one handy, and using the same brand for the CPU cooler and the case tends to cut down on incompatibility.

The 380T can fit a videocard up to 11.4 inches long, but we preferred the shorty GTX 970 to give us some room to breathe. This plugs into an Asus Maximus VII Impact, which is a fancy ITX mobo that uses Intel's Z97 chipset. On CPU duty is the Core i7-4790K, which was the beefiest chip we could put in this mobo. Powering the whole shebang is a gold-rated Cooler Master V550. For storage, we have just a single SSD, since this unit is purpose-built for LAN gaming. The 380T will fit up to two 3.5-inch drives, though, and up to four 2.5-inch drives.

INGREDIENTS

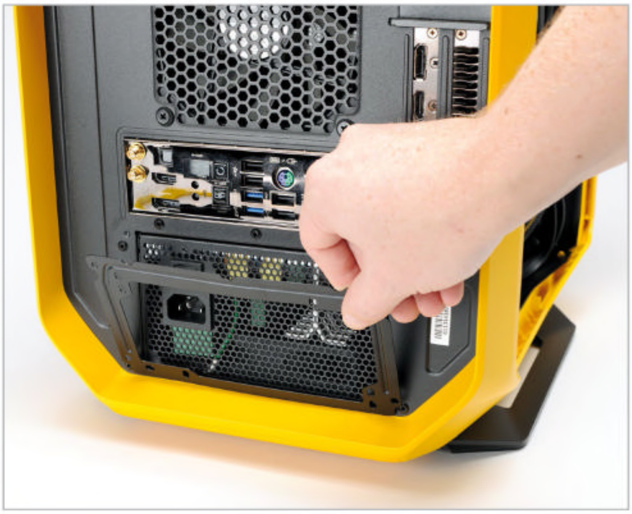
PART		PRICE
Case	Corsair Graphite Series 380T	$150
PSU	Cooler Master V550 550W	$75
Mobo	Asus ROG Maximus VII Impact	$220
CPU	Intel Core i7-4790K	$340
GPU	Asus GTX 970 DC Mini	$350
RAM	2x 8GB Corsair Vengeance Pro	$145
SSD	1TB Samsung 850 EVO	$450
OS	Windows 8.1 64-bit OEM	$100
Total		$1,830

1

METHOD TO THE MADNESS

MINI-ITX CASES, in our experience, all tend to have a number of their own little quirks and unusual deviations. Luckily, however, they generally all make sense when placed in context. This plate, for example, craftily unscrews from the back and allows you to slide in a power supply through the rear of the case. If you're wondering why, well, it's because this case doesn't have enough room to install the PSU from the side.

The 380T can take a PSU up to 180mm long, but you'll have to account for PSU cables, too, if you want to keep hold of the drive cage that's right next to it. That's why we opted for the V550 PSU, which is is 140mm long—we wouldn't recommend pushing very far past 150mm. Connect your modular cables before sliding the PSU in, too, as it's cramped on the other side.

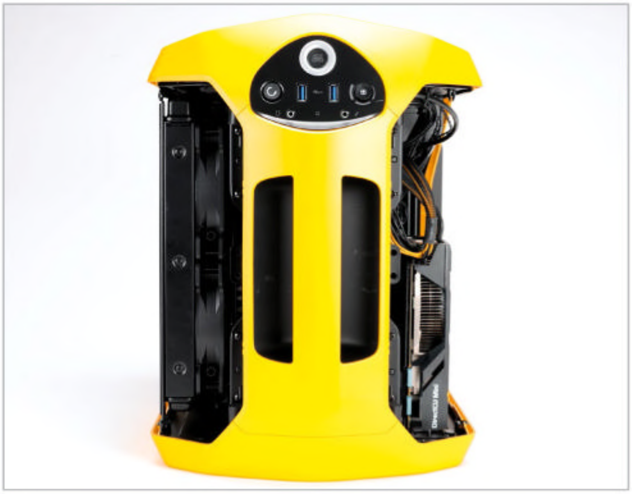


2

ROOM WITH A VIEW

THE TWO SIDE WINDOWS of the 380T come off just by pulling on their handles. As you can see from the top-down photo, though, the mobo is obscured, leading to some tactical considerations. For example, your CPU cooler must be attached to the mobo before they go in the case or you won't be able to screw down the cooler. You can get around it with a short enough screwdriver, but then you don't have much torque.

If you're using a cooler with a radiator attached, you must pull the rad through first. Our 240mm rad also barely fit lengthwise, though the case could accommodate one that's thicker than normal. For the best airflow, we'd recommend pointing the rad's fans on the inside, blowing outward and through it.



3

I'M YOUR BIGGEST FAN

TO POP OFF THE FRONT GRILL, just push its upper-left and upper-right corners until you hear them click, and it's released. The stock 140mm intake fan can be replaced with two 120mm fans or one 200mm fan—the largest option will be the quietest (though you can get high-performance fans at any size). The round holes on each corner are for threading the fan's power cable back into the case. This fan lights up with a white LED, but there's a tiny switch next to the handle in the top of the case that can toggle that off. And just FYI, there's no room in front for another radiator.

4

COOL CUSTOMERS

FROM THE OTHER SIDE OF THE CASE you can see just how tightly the CPU cooler's radiator is tucked in there. The tubes also have to be oriented to go into the rad on the far end of the case. If you try to orient the tubes to come out near the motherboard, they will be obstructed by the case's exhaust fan. You could remove the exhaust fan, but you'd sacrifice a lot of airflow. And we didn't notice it at first, but a partially hidden screw also allows you to remove the drive cage, so you could install a pump and a small reservoir if you wanted to do a custom water loop. You can also get pumps that integrate their own res, but a res that small also restricts how much you can cool—you'd be able to do a GPU or a CPU, but probably not both.

5

CONTROL FREAKS

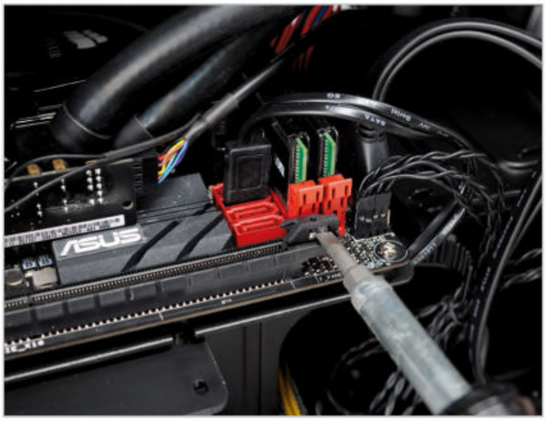
YOU MIGHT WONDER how a Mini-ITX case could cost $150. One of the reasons is the integrated three-speed fan controller. In our scenario, we used this to control the front and rear fan. We could've plugged in the CPU cooler pump as well, but you want to either run that at full speed, or let it use PWM temperature measurements to regulate its own speed. So we plugged the pump into the spare motherboard fan header instead. The cable on the stock exhaust fan is plenty long enough to reach these connectors. There's a fat button on the top of the case with a fan icon on it, and you just press that to cycle through each speed setting.

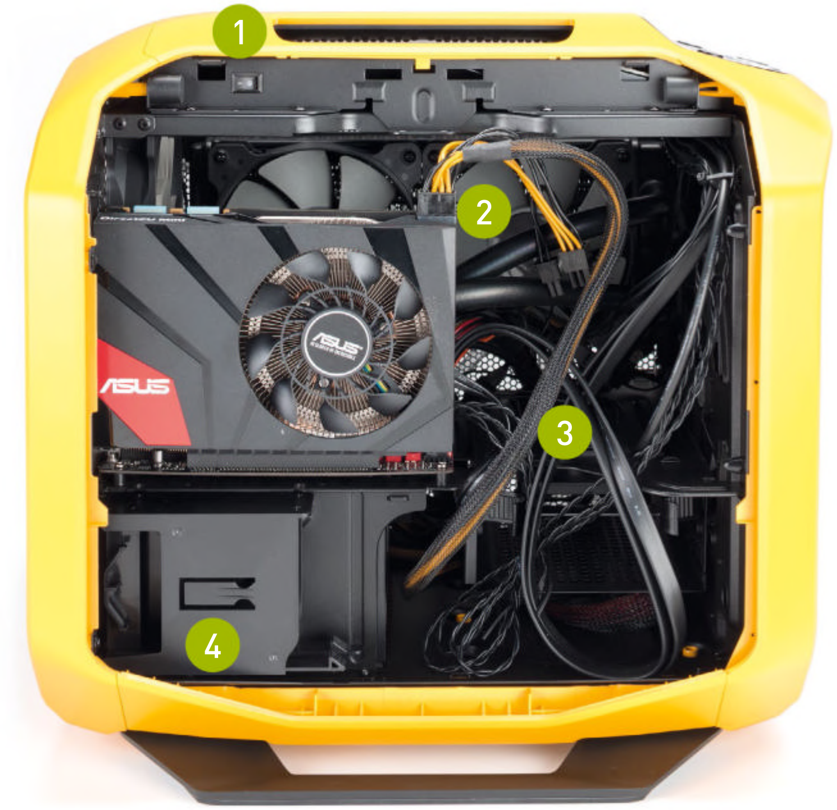
The controller itself gets juice through a SATA power connector, so make sure you've a spare before you install all your SATA-based storage devices. Our CPU cooler also uses a SATA power connector, so we'd need a second cable of that type to install more than two SATA drives.

6

POPPING LOCKS

SOMETIMES THE TRICK isn't with the case, but with the hardware inside it. During the course of building a PC, especially one as unique as this one, you will often have to undo a few steps and work your way back. If you aren't familiar with this motherboard, that could prove a little challenging. Most boards use locking mechanisms on the videocard slot to make sure the card doesn't slide out accidentally. This one has an actual spring-loaded latch with a small knob that goes through a notch in the card, rather than a lever-like handle that you can just push out of the way (usually with a spare slot cover).





1 **Here's the switch to turn off the LED on the front intake fan. You can't reach it from outside, but the side panel pops off easily.**

2 **The Asus GTX 970 DC Mini needs only one 8-pin PCI Express power cable to run, so it doesn't need a fancy power supply.**

3 **You have nearly five inches of space between the end of this videocard and the front of the case, so your cable routing can still be a little relaxed.**

4 **This is a rotated drive cage that can hold two 2.5-inch drives. We'd definitely recommend right-angle SATA data cables here.**

SUNNY SIDE UP

ONE OF THE NICE THINGS about these compact ITX cases is that you can rotate and tip them easily, during and after the build process. The side panels on the Corsair 380T also come off with a flick of the wrist, so gaining access to any angle of the system is a breeze. Speaking of breezes, the large grills on the panels, plus the large front grill on the front and the exhaust fan on the back, make for some serious airflow. We had no trouble keeping this system ventilated. The shorty GTX 970 videocard did make more noise than a card of standard length, so we'd recommend a full-length card if your ears are sensitive to that. Just make sure you stay comfortably under that 11.4-inch limit.

CPU cooler height is also limited to 150mm, which will eliminate a number of tower-style air coolers from consideration. So we'd recommend a closed-loop cooler if you can afford one and are overclocking. It has to be either 120mm or 240mm, mind; the bracket doesn't fit 140mm or 280mm radiators or fans.

We also debated whether to go with an Intel Core i5 or i7 CPU. The latter is more or less an i5 with Hyper-Threading. HT gives you four additional CPU threads, for a total of eight, but it's not like having four extra physical cores. They're more like a simulation. Still, since Direct3D 12 and Mantle let your videocard communicate with multiple CPU threads at the same time (DirectX 11 and earlier versions only talk to one CPU thread at a time), having a lot of threads could boost performance in future games, depending on how they handle this new feature. In the end, we were already spending nearly $1,500 on this system before we'd added the CPU, so adding a $100 premium for the i7 wasn't a big deal.

Either way, you'll get some pretty snappy performance from this system. It took well under 30 seconds to do a full reboot, which helps a lot when installing Windows, Windows updates, drivers, and certain software. Our GTX 970 averaged over 80fps in *Batman: Arkham City* with 4xMSAA and everything else maxed out (though we did disable PhysX). With a whopping 4GHz base clock, our Core i7-4790K whipped through all the benchmarks like a samurai sword (on a core count basis, that is). In fact, it might be time to retire our legendary zero-point system and replace it with something even heavier. ⏻

BENCHMARKS

	ZERO-POINT	
Premiere Pro CS6 (sec)	2,000	2,346
Stitch.Efx 2.0 (sec)	831	739 -12.5%
ProShow Producer 5.0 (sec)	1,446	1,270 -13.8%
x264 HD 5.0 (fps)	21.1	19.2 -9.8%
Batman: Arkham City (fps)	76	85
3DMark 11 Extreme	5,847	4,914 -19%
		0% 5% 10% 15% 20% 25% 30% 35% 40% 45% 50%

The zero-point machine compared here consists of a 3.2GHz Core i7-3930K and 16GB of Corsair DDR3/1600 on an Asus Sabertooth X79 mobo. It has a GeForce GTX 690, a Corsair Neutron GTX SSD, and 64-bit Windows 7 Professional.

BUILD IT

TOM MCNAMARA **TECHNICAL EDITOR**

Video Production On-the-Go

We discover that balancing size and power is a delicate process when building a specialist content creator rig

LENGTH OF TIME: **1–2 HOURS**

LEVEL OF DIFFICULTY: **LOW**

THE MISSION

SOMETIMES WE BUILD SYSTEMS just to test out the latest hardware, or to experiment with different ideas. In this build, we're constructing a purpose-built machine. With YouTube, Twitch, and other video sites becoming increasingly integrated into our daily lives, it's a good time to think about what we use to create this content, rather than what we use to watch it. And if you want to start your own YouTube channel or get involved with video creation, you don't need a super computer.

As long as you have a CPU with four or more cores, a few hard drive trays, and a decent videocard, you can get along just fine. These bullet points are reasonable enough that we can fit them into a pretty low-profile PC that you can truck around without throwing your back out. With the type of case that we chose, you can also fit a full-sized power supply, high-performance CPU cooler, and full-length videocard. This case is even designed to stack with multiple units of the same base model.

COOLER MASTER

AN EYE FOR ITX

WE'VE BUILT WITH "SHOEBOX" PC CASES before, and they taught us that things can be a pain, due to their sheer compactness. Silverstone even ships some cases with power supplies pre-installed, along with custom shortened cables. They've a minimal footprint on your desktop and look cool, but woe betide you if you need to troubleshoot anything—you'll need to unpack entire chunks of PC guts to get at the problem, usually. So we wanted a shoebox that was reasonably easy to build into and out of. Especially with video encoding, where you want the ability to swap hard drives in and out. The Cooler Master HAF Stacker cases make those drives easy to access. You can also choose a case with the PSU mount on the front or on the back. We went with the front mount to keep the weight of the case balanced.

Inside this case we've used an Asus ROG Maximus VII Impact mobo, which employs the Intel Z97 chipset and offers up a selection of its own handy features, too. We've kept costs down by putting an Intel Core i5-4670K CPU at the build's heart, and we've the ever-popular Cooler Master Hyper 212 Evo for some moderate overclocking. Our videocard is the Sapphire Radeon R9 285 Compact, which is roughly equivalent to a GeForce GTX 760. Our storage is a Samsung 850 EVO SSD and two 3TB hard drives from Seagate.

INGREDIENTS

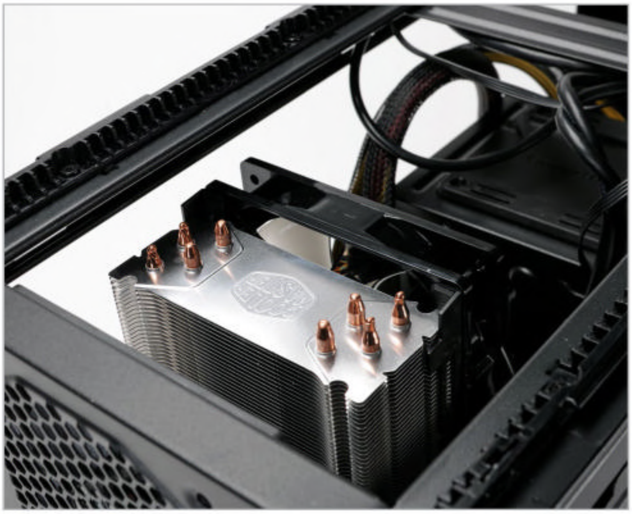
PART		PRICE
Case	Cooler Master HAF Stacker 915F	$65
PSU	Cooler Master V550 550W	$80
Mobo	ASUS ROG Maximus VII Impact	$230
CPU	Intel Core i5-4670K	$230
GPU	Sapphire Radeon R9 285 Compact	$240
RAM	2x 8GB Kingston Fury Black	$150
Drive Cage	HAF Stacker 935 Storage Kit	$12
HDD	2x Seagate Barracuda 3TB	$200
SSD	250GB Samsung 850 EVO	$140
OS	Windows 8.1 64-bit OEM	$100
Total		$1,447

1

CART BEFORE THE HORSEPOWER

IF YOU'RE USING an aftermarket CPU cooler like we are on this occasion, you'll need to install its backplate on the motherboard before thinking about getting the board into the case. These ITX cases generally don't have cut-outs that enable you to access the motherboard tray from the other side. Thankfully, this is an easy task with the 212 Evo cooler.

For our LGA 1150 board, you choose the middle of the backplate's three screw positions, then put the mounting screws in, and fasten the screws on the other side of the board with the nuts that should be provided. Our board also has a tall riser card, so we needed to shift the CPU fan vertically a few notches to make sure that everything fit. Low-profile RAM is also something highly recommended.



2

AIN'T THE SIZE OF THE BOAT

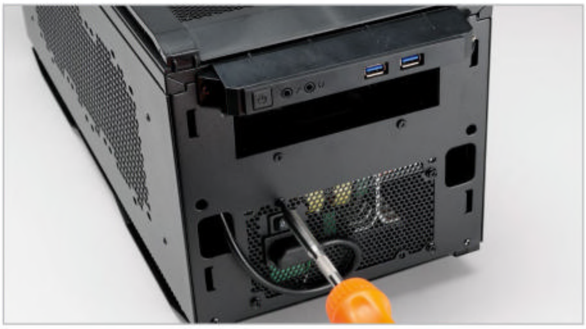
THIS SAPPHIRE COMPACT VIDEOCARD is short enough for us to install this three-tray drive cage right in front of it. Without that, we're limited to the drive mount on the 5.25-inch bay (which is removable), the one below this drive cage, and the one on a reinforcement plate (which we removed for this build). This cage also has enough room behind it that we don't require right-angle SATA cables.

This case doesn't actually come with a 3.5-inch drive cage; you need to order the HAF Stacker 935 Storage Kit from Cooler Master to get it. The SATA cables that come with our motherboard aren't long, so we slapped them in, too. It doesn't matter which port you use on the motherboard end—they can all do SATA III speeds.

3

BACKWARD AND FORWARD

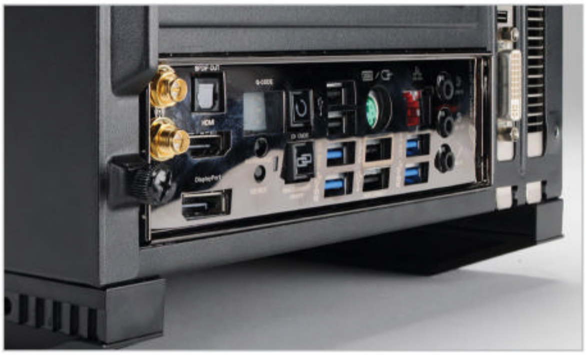
HERE WE HAVE THE FRONT OF THE CASE with the bezel taken off. This right-angle power cable gets juice to the power supply while lying flat enough to fit behind the bezel. The PSU's power switch ends up on the inside of the case, which is a bit awkward. But the bezel pops off pretty easily, giving you access to the switch in a pinch. (We should also add that this is a pre-production version of the HAF Stacker, because we're hardware hipsters. Some cosmetic stuff is different from the retail version.) The case has an intake fan below the PSU mount, and its heat is exhausted through the front of the case. Sometimes ITX cases make their PSUs expel heat into the case, which may cause overheating or lower your overclock ceiling. For our needs, this 550-watt unit is plenty. If you put in a 290 or 290X, though, we'd recommend bumping it up to 600 watts.



4

A LOVER, NOT A WI-FIGHTER

THESE TWO GOLD-PLATED COAXIAL CONNECTORS are for the motherboard's integrated Wi-Fi. You definitely want some of that in an ITX system, since it will have only one PCI Express card slot on the motherboard, and you want to use that for your videocard. Since our system is designed for mobility, we don't want to have to rely on Ethernet for network access. These coax connectors each have a nut and a washer that you need to remove before putting the connectors through the back of the I/O shield here. You re-attach them on the other side, and your coax is secure. This Asus motherboard comes with an antenna on a cable about two feet long, from which we were able to get a strong connection. Windows 8.1 recognized the adapter right out of the box, which made our initial setup much easier.



5

GETTING HIGH

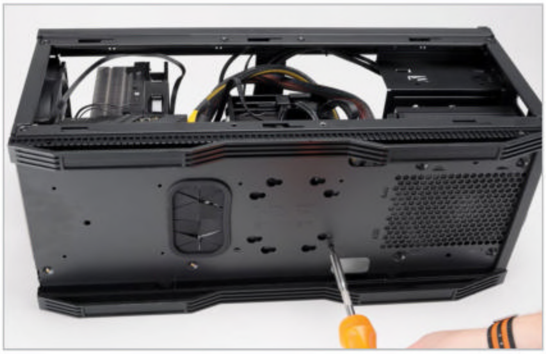
THIS IS WHAT THE INSIDE of the HAF Stacker's side panel looks like. It has "captured" thumbscrews, which means they stay attached even when fully unscrewed. It's basically one big grill with a bunch of fan mounts. You can mount two 140mm fans or up to three 120mm fans. In practice, you can't use all of these, because internal components get in the way. The top of the case has no fan mounts, but it's also one giant grill. In case you were wondering, HAF stands for "High Air Flow." Cooler Master aren't kidding.

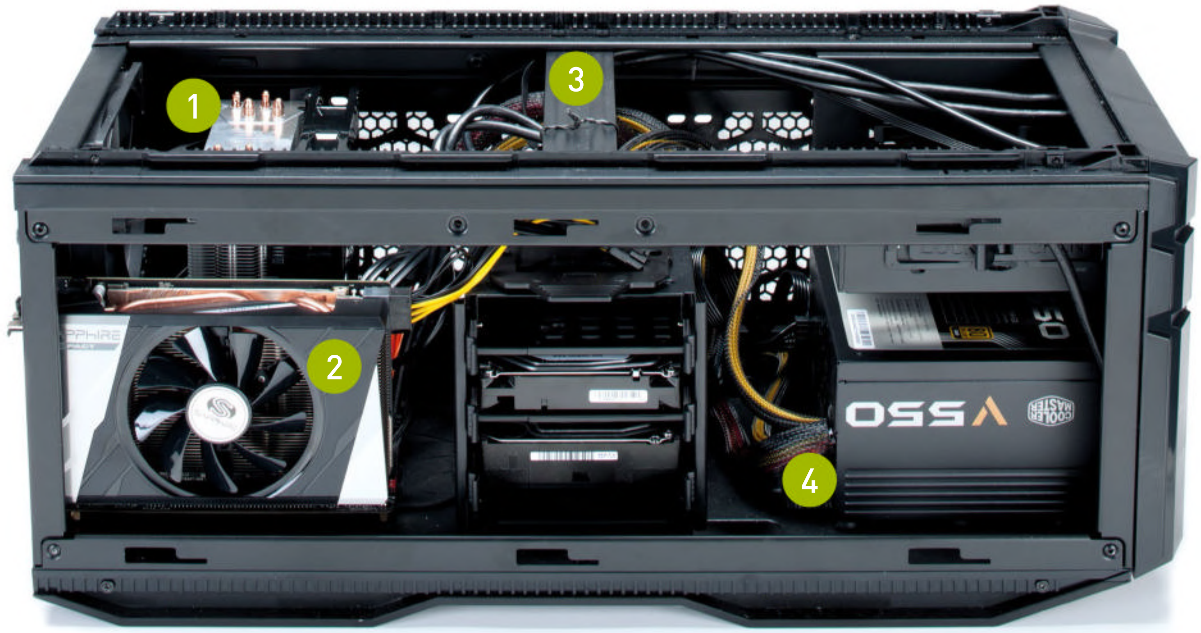
The other side panel is identical, so you can squeeze more fans in. We kept it simple and stuck with the 120mm stock exhaust fan. This ITX mobo has only two fan headers anyway, so we'd have to plug extra fans directly into the power supply, which can be noisy. On the other hand, you could use that 5.25-inch bay to install a fan controller, if you don't mind sacrificing the bay's drive mount.

6

TANGLES AND DANGLES

THE UNDERSIDE REVEALS a couple of interesting things. Besides the drive mount, there's a set of rails and a rubber grommet. The rails give clearance for the power supply's intake. But you can also remove them and connect a second HAF Stacker. That's how the case gets its name. The grommet is for feeding data and power cables between the two cases, so they can share storage devices and a power supply. Three of these 915 cases stacked on top of each other will be roughly the height of a full ATX tower. Cooler Master also sells a "935" SKU, which combines this 915 with a 925 mid-tower that they don't sell separately. The 935 has Stacker attachment mounts both on top and on bottom, so you could build something pretty colossal.





1 You could actually squeeze a second CPU fan on the other side of the cooler, and the 212 Evo comes with an extra set of clips for that.

2 This Radeon R9 285 boasts just one fan, but doesn't generate much heat anyway. Even so, it performs better than the Radeon 280.

3 We put a twist tie here to secure the thick USB 3.0 cable coming from the front panel. You can also lift the case by this crossbar.

4 The PSU is 5.5-inches/140mm long. As you can see from the photo, you could go another half inch without meeting too much trouble.

IT'S A QUIET RIOT

WE MADE SURE only one drive was connected when we installed Windows, otherwise it puts a "system" partition on a drive other than the SSD. We wanted to be able to swap out the other drives, and putting the system partition on one of them makes Windows unbootable if that drive is disconnected. While we were installing Windows, we noticed it didn't recognize the mobo's integrated Ethernet adapter, which uses an Intel I,218V chip, even though it recognized the integrated Wi-Fi. We're used to the opposite being the case.

We used the Wi-Fi connection to download the Ethernet drivers, along with the latest versions of AI Suite (for managing fan speeds, monitoring temperatures, and doing some tweaking), and HomeCloud. We needed HomeCloud to enable Wifi GO, a feature that allows you to use this motherboard as a wireless hotspot, a nice extra. If your system boots without Ethernet or wireless connectivity, you can pull older drivers off of a DVD bundled with the board, or you can download the drivers to a mobile device and transfer them via a USB cable.

With just one 120mm fan in the case and another on the CPU cooler, this was a pretty quiet build. In fact, we actually removed a side panel to check the fans were spinning. Of course, the CPU fan cranks up a bit when the chip is firing on all cylinders, but it shouldn't be distracting. We took this opportunity to update the BIOS, since the newest one said it improved stability, and the one before claimed to improve performance. It's unfortunate mobo vendors are so vague about what their BIOS updates do. Either way, we couldn't resolve an issue where the PC wouldn't boot when we had a USB thumb drive plugged in.

Since we're not testing new hardware, there aren't any benchmarks to run. This build was more about concept and execution. The results will vary a lot according to what kind of video footage you're dealing with and what programs you use to edit and encode. But the Radeon R9 285 is on Adobe's "approved" list for hardware-accelerated encoding via OpenCL, and four Haswell CPU cores pack plenty of performance poke, too.

By default, this Asus motherboard will set all cores on the i5-4670K to 3.8GHz, when a load is applied. That's the CPU's official maximum "Turbo" setting, which happens when you put a load on the chip. Without this motherboard setting, one core will run at 3.8GHz when only one core is being used. When all four are in action, they'll run at 3.5GHz each. When three are being used, they'll run at 3.6GHz each; for two, they'll run at 3.7GHz. The motherboard's "Sync All Cores" setting streamlines this business and gives you a performance edge for video encoding, which typically uses all the cores and threads that you can throw at it.

If you have some downtime, this system doubles as a respectable gaming rig. We averaged 79fps in the *Tomb Raider* benchmark, using the "Ultimate" setting at 1920x1200 with TressFX disabled. *The Hitman: Absolution* benchmark averaged 48fps on "Ultra" with 4xMSAA. This compact 285 retails at a higher price than average, so it's not the best bang for your buck, but it's the best value after you've factored in size. Nvidia's partners have started coming out with mini versions of the GeForce GTX 970, but those are about $100 more.

Overall, we're happy with how this system turned out, though we might have opted for a less expensive motherboard, since the Maximus VII Impact is designed to take advantage of more exotic CPU cooling than a Hyper 212 Evo. ⏻

GET MORE SPEED FOR FREE!

52 Time-Saving Tips and Tricks

BY ALEX CASTLE

After a while, every PC starts to show its age. Programs that used to be lightning fast suddenly start to go slow. Tasks that used to take five minutes now take 10. Using your computer for anything in fact starts to feel like a chore. In short, a once-lovely machine becomes a liability, dragging your productivity through the dirt and wasting your precious time.

Fortunately, there's always a way to speed up a PC, whether it's a 7-year-old clunker or last year's model that's just starting to slow. Hell, you can even wring some extra performance out of a brand new PC, if you know what to do. In this article, we're going to share a whopping 52 ways to get more horsepower out of any PC, covering hardware, software, and operating system tweaks. Best of all, each one of them is completely free. Everyone who's ever said there's no such thing as a free lunch is wrong—you can reclaim lost speed without ever spending a cent. Why not start right now?

COVER & MAIN FEATURE IMAGE: OVERCLOCKERS UK WWW.OVERCLOCKERS.CO.UK

SLI

SORT OUT YOUR SOFTWARE

Transform your PC into a steroid-stacked sprinter by fine tuning your OS and other software

Although a computer is a machine, the most common sources of slowdown are anything but mechanical. Instead, it's the operating system and software that cause most of the problems that can turn a new computer into a plodding soul-destroying mess. And it's those same two layers where most of the easiest performance gains are to be found.

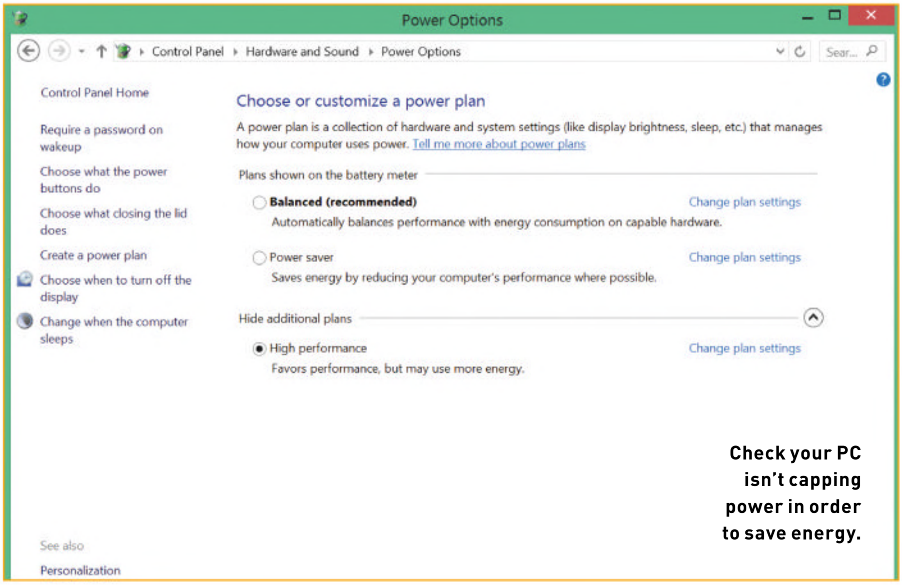
On the following pages, we're going to look at fixes for common software speedbumps, as well as Windows tweaks that will get your computer running faster than ever before.

OS TWEAKS

The operating system you're using is the foundation of your computer, which means that even the fastest software will limp slowly if the operating system it runs on is sluggish and simply not up to the task. Accordingly, the first place you should always look for speed-boosting tweaks is within Windows itself.

1 CHANGE THE POWER SETTINGS TO HIGH PERFORMANCE

If your computer seems like it's going slower than it should, check the Power Options menu in the Hardware and Sound section of the Control Panel and make sure you have the "High Performance" setting selected. On a laptop, Windows will sacrifice performance in the name of increased battery life, by putting components like hard drives to sleep faster, or even capping the maximum output of the CPU. For fine-grained control over your PC's power settings, click the "Change plan settings" link next to the power plan you've selected, then click "Change advanced settings."


Power Options
Control Panel › Hardware and Sound › Power Options
Sear...
Control Panel Home
Require a password on wakeup
Choose what the power buttons do
Choose what closing the lid does
Create a power plan
Choose when to turn off the display
Change when the computer sleeps
See also
Personalization

Choose or customize a power plan

A power plan is a collection of hardware and system settings (like display brightness, sleep, etc.) that manages how your computer uses power. Tell me more about power plans

Plans shown on the battery meter

○ **Balanced (recommended)** Change plan settings
Automatically balances performance with energy consumption on capable hardware.

○ Power saver Change plan settings
Saves energy by reducing your computer's performance where possible.

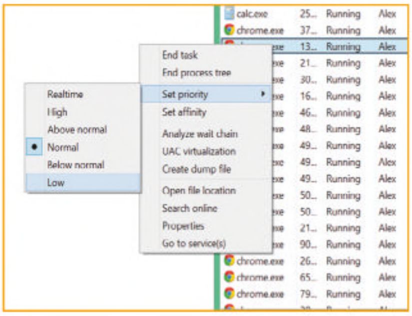
Hide additional plans

● High performance Change plan settings
Favors performance, but may use more energy.

Check your PC isn't capping power in order to save energy.

2 TURN OFF AERO

First introduced in Windows Vista, Aero is the name for the set of interface eye candy that includes transparent UI elements and animated window transitions. It makes post-XP Windows look slicker and more modern, but it can also have a surprising effect on system performance. In particular, older systems without discrete graphics hardware can get a substantial performance boost by disabling Aero in the Appearance section of the Control Panel. Yes, you'll miss out on a bit of graphical flair, but the actual functioning of Windows will be completely unaffected.


calc.exe 25... Running Alex
chrome.exe 37... Running Alex
End task
End process tree
Set priority
Set affinity
Analyze wait chain
UAC virtualization
Create dump file
Open file location
Search online
Properties
Go to service(s)
Realtime
High
Above normal
● Normal
Below normal
Low
chrome.exe 26... Running Alex
chrome.exe 65... Running Alex
chrome.exe 79... Running Alex

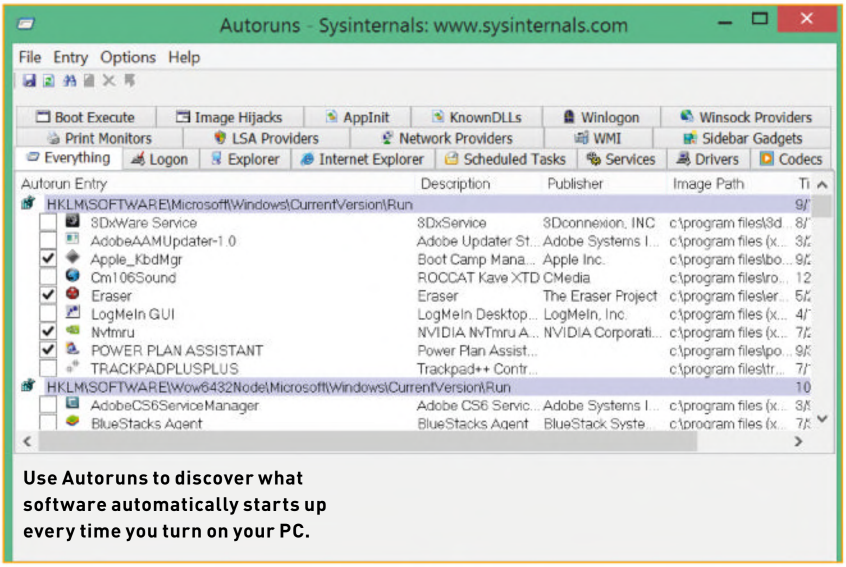
3 MANUALLY SET THE PROCESSOR PRIORITY LEVEL

Nothing will bring your computer grinding to a halt faster than a program that's monopolizing your processor. Even if your PC isn't actually locked up, other software you try and use will be miserably laggy. When the resource-hogging program in question is something you actually need to let finish, it can leave you with no good option—you either don't let the program finish, or you give up on doing anything else until it's done. Fortunately, Windows has an easy way to manually set processor priority. Just open the Task Manager, click over to the "Processes" or "Details" tab, then right-click on the offending program, and set the priority to "Low." Now Windows will know to allocate resources to other programs first, and your original program will still be able to complete without a fuss.

4 USE RESOURCE MONITOR TO SPOT THE SLOWPOKES

Speaking of the Task Manager, you should know there's a more powerful version of that tool built right into Windows 7, 8, and Vista. Just open the Task Manager,

37 Reboot! It has to be said—a lot of problems will be solved with a system reboot. *38* Restart the router Mysterious problems
taskbar app by hitting WIN and the number key corresponding to that program's position on the taskbar. *40* Switch to OpenDNS



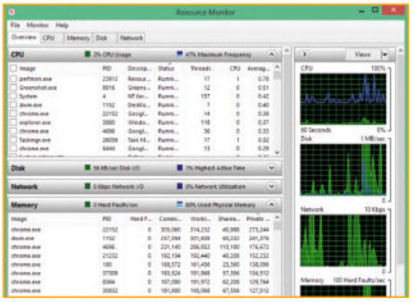
	Autorun Entry	Description	Publisher	Image Path	Ti
	HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Run				9/
☐	3DxWare Service	3DxService	3Dconnexion, INC	c:\program files\3d...	8/
☐	AdobeAAMUpdater-1.0	Adobe Updater St...	Adobe Systems I...	c:\program files (x...	3/
☑	Apple_KbdMgr	Boot Camp Mana...	Apple Inc.	c:\program files\bo...	9/
☐	Cm106Sound	ROCCAT Kave XTD	CMedia	c:\program files\ro...	12
☑	Eraser	Eraser	The Eraser Project	c:\program files\er...	5/
☐	LogMeIn GUI	LogMeIn Desktop...	LogMeIn, Inc.	c:\program files (x...	4/
☑	Nvtmru	NVIDIA NvTmru A...	NVIDIA Corporati...	c:\program files (x...	7/
☑	POWER PLAN ASSISTANT	Power Plan Assist...		c:\program files\po...	9/
☐	TRACKPADPLUSPLUS	Trackpad++ Contr...		c:\program files\tr...	7/
	HKLM\SOFTWARE\Wow6432Node\Microsoft\Windows\CurrentVersion\Run				10
☐	AdobeCS6ServiceManager	Adobe CS6 Servic...	Adobe Systems I...	c:\program files (x...	3/
☐	BlueStacks Agent	BlueStacks Agent	BlueStack Syste...	c:\program files (x...	7/

Use Autoruns to discover what software automatically starts up every time you turn on your PC.

then click on the "Performance" tab. Towards the bottom of that menu, you'll see a button to open the Resource Monitor. The Resource Monitor is an exceptional tool for finding the programs that are slowing down your PC, with very detailed usage charts for CPU, memory, hard disk space, and even network bandwidth that they're taking up.

5 CLEAN UP YOUR STARTUP FOLDER

A major sign of a computer in need of maintenance is a slow boot time. If your computer takes forever to get started, it generally means you've got a lot of software starting up whenever your operating system starts. That's bad for a number of reasons. First, it means Windows has to get more done before it finishes booting. Also, all that software running in the background drains system resources and causes an overall slowdown. One of the best things you can do to speed up your PC is to use a free program such as Autoruns (http://bit.ly/MlIdLk) to examine what's starting up with your PC. Chances are you'll find a lot of stuff on the list that shouldn't be there. Have a thorough look through it and disable anything you really don't need.



Resource Monitor will hunt down the programs making your PC run slower.

OTHER SOFTWARE TWEAKS

Software can be part of the problem or part of the solution. Some programs are well-intentioned, but make your whole system slower, while others are actively malicious. On the other hand, the right software can help you reclaim lost speed and keep you safe. In this section we'll look at both.

6 CLEAR UP WASTED SPACE WITH CCLEANER

It never pays to be a software hoarder. As with the startup folder items described in the previous tip, excess installed software eats up your hard drive space and jams up your Start Menu, context menus, and more. You can try and uninstall unnecessary programs by hand, but it's a lot easier with the aid of an uninstaller app such as CCleaner, which presents a list of your installed applications, and lets you perform one-click uninstalls. Visit www.piriform.com/ccleaner to download it.

7 DO A MALWARE SCAN

If your computer has experienced a sudden and dramatic slowdown, the most likely culprit is malware. Even if you're sure you never installed anything untoward, it's a good idea to periodically run a malware scan. You can't go wrong with Malwarebyte Anti-Malware (www.malwarebytes.org).

8 DROP THE COMMERCIAL ANTIVIRUS

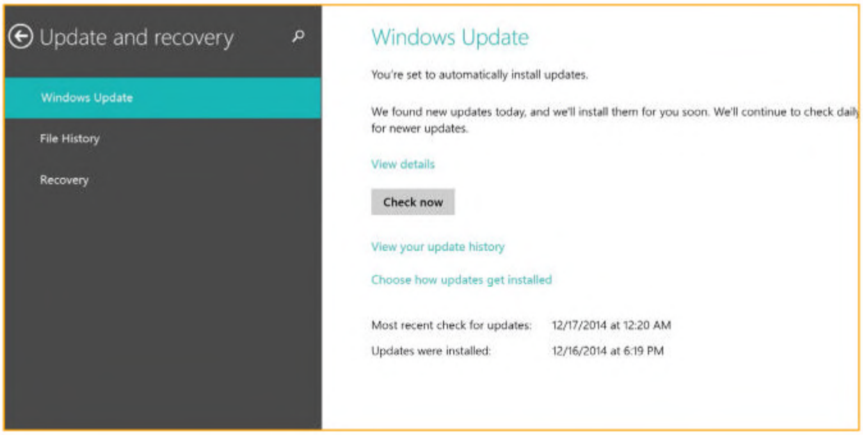
These days, commercial antivirus is likely to cause as many problems as it fixes. If you keep Windows current, then the included Windows Defender antivirus will be enough to protect your computer from common attacks. Practice basic web safety (don't open email attachments from people you don't know, etc.) and you'll stay safe without any security bloatware.

9 MAKE SURE WINDOWS IS ALWAYS UP TO DATE

As described previously, you have to keep Windows current in order for Defender to do its job. Automatic updates might be a pain when they happen, but you'll save time in the long run if you keep your computer secure. You can find Windows update settings in the System and Security tab of the Control Panel.

10 UPDATE YOUR VIDEO DRIVER

Most drivers are handled automatically these days, but you should still regularly check your video driver is up to date, especially if you plan to do any gaming. The video driver is performance-critical, and can be the source of a lot of in-game glitches. Additionally, updates are frequently published that increase speed in newly released games, so check back often and you might be pleasantly surprised.



You're set to automatically install updates.

We found new updates today, and we'll install them for you soon. We'll continue to check daily for newer updates.

Most recent check for updates: 12/17/2014 at 12:20 AM

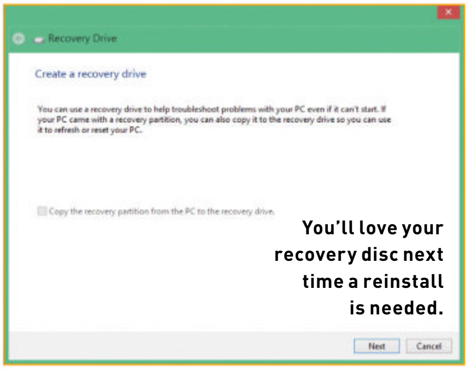
Updates were installed: 12/16/2014 at 6:19 PM

Keeping Windows updated helps Defender do its antivirus job.

plaguing your Internet connection? A simple router/modem reboot can help. *39* Launch taskbar apps with a hotkey Launch any
If your ISP's DNS server is slow, web pages will take a long time to load. Switch to OpenDNS at www.opendns.com. *41* Move files

MORE SOFTWARE TWEAKS

From Linux to LibreOffice, don't be scared to try the alternatives



Recovery Drive

Create a recovery drive

You can use a recovery drive to help troubleshoot problems with your PC even if it can't start. If your PC came with a recovery partition, you can also copy it to the recovery drive so you can use it to refresh or reset your PC.

☐ Copy the recovery partition from the PC to the recovery drive.

Next
Cancel

You'll love your recovery disc next time a reinstall is needed.

REINSTALL WINDOWS

Most of the issues that slow your computer down can be fixed with a little TLC. As we've been discussing, malware can be cleaned up, application clutter can be pruned, and so forth. Still, sometimes a computer can become so completely, utterly hosed that no amount of maintenance can fix it. The only way to unhose such a machine is to start fresh with a new Windows installation. If you've reached that point with your computer, here's a few things to keep in mind as you reinstall Windows.

11 RECLAIM YOUR PRODUCT KEYS

It's frustrating to reinstall your OS only to realize you've forgotten a CD key and can't reinstall important software. A program such as Enchanted Key Finder (sourceforge.net/projects/ekeyfinder/) can automatically find most or all of the active CD keys on your system. Especially for industry-level applications like Photoshop, you should manually deactivate your software before uninstalling, in order to save yourself time later on.

12 MAKE A RECOVERY DISC

Make your life easier next time you have to reinstall by creating a recovery disc of your newly clean PC. In Windows 8, you access the recovery media utility by opening the Start screen, typing "recovery" and selecting the option labelled "Create a recovery drive." The recovery drive will allow you to restore your computer to exactly this lovely fresh state without having to do a full reinstall.

13 BACK UP YOUR FILES

This goes without saying, and is something you should be doing anyway. Make sure you've got all your important files backed up to an external drive or the cloud. Even if your files are on a separate partition from your Windows install, it's better to be safe than sorry.

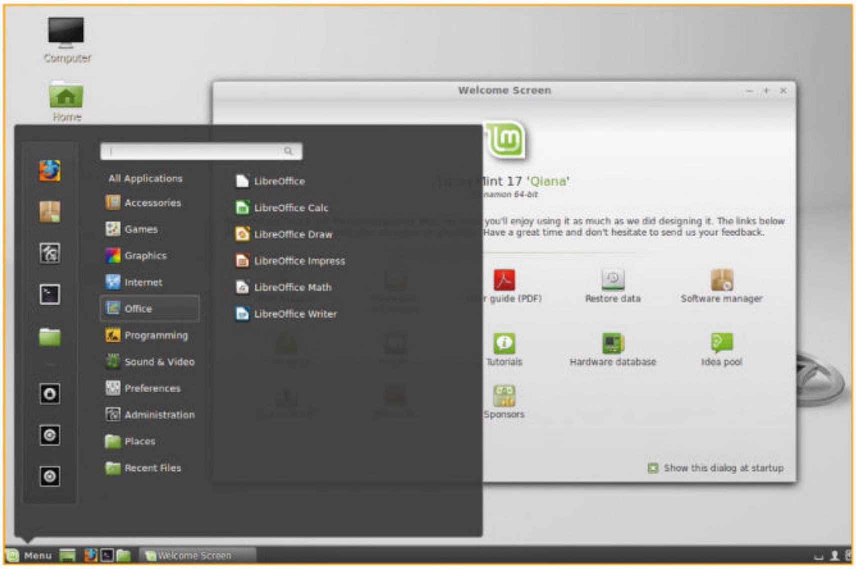
TRY A DIFFERENT OS

Though we're generally big fans of Windows, we'd be remiss if we didn't mention that reinstalling Windows isn't the only way to get a clean start.

14 MINTY FRESH

You could also try a shiny new installation of a free alternative OS from the Linux family. Linux OSes are lighter-weight than Windows, and generally have much easier system requirements. You can install one as a secondary OS, and only boot to it when you want a more minimal desktop experience. If you've never tried Linux before, it might seem daunting, but it's actually not that tricky with today's user-friendly Linux distros. In fact, the hardest part might be picking which distro (a specific Linux-based operating system) to install. For years, the standard recommendation for newbies has been Ubuntu, which is polished, well-supported and very user friendly. It's still a great option, but lately we've taken to recommending Linux Mint (www.linuxmint.com) instead.

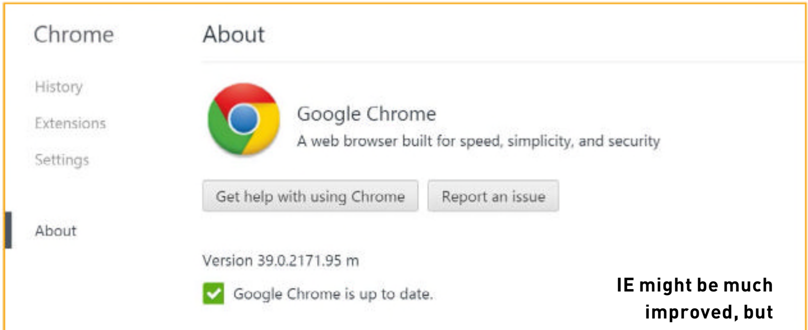
Linux Mint is based on Ubuntu, and offers the same professional-quality experience and easy installation. Where it differs is in the user interface—the UI in Mint is a little more minimalist and will be more familiar to those coming from Microsoft OSes. There will obviously still be a learning curve, but you can generally get set up with a fully functional Linux desktop in an afternoon.



Computer
Home
Welcome Screen
All Applications
Accessories
Games
Graphics
Internet
Office
Programming
Sound & Video
Preferences
Administration
Places
Recent Files
LibreOffice
LibreOffice Calc
LibreOffice Draw
LibreOffice Impress
LibreOffice Math
LibreOffice Writer
Mint 17 'Qiana'
Cinnamon 64-bit
you'll enjoy using it as much as we did designing it. The links below
Have a great time and don't hesitate to send us your feedback.
User guide (PDF)
Restore data
Software manager
Tutorials
Hardware database
Idea pool
Sponsors
Show this dialog at startup
Menu
Welcome Screen

Alternative operating systems such as Linux Mint are less demanding on your system.

quick with Send To Right-click a file and expand the Send To options to immediately move it to a number of commonly accessed
prompt anywhere In File Explorer, hold Shift and right-click in a folder. You'll see an option to open a new command prompt in



Google Chrome
A web browser built for speed, simplicity, and security

Version 39.0.2171.95 m

☑ Google Chrome is up to date.

IE might be much improved, but Chrome and Firefox are faster.

TRY A FEW DIFFERENT APPS

Sometimes the best way to get a quick performance boost is to replace an often-used piece of software with a speedier alternative. That can mean giving up some functionality, but more often than not that's a tradeoff worth making. Here are five common apps you might replace:

15 INTERNET EXPLORER

It used to be the case that the best advice you could give someone regarding their web browser was to drop Internet Explorer as fast as humanly possible. Fortunately, IE isn't the absolute stinker it used to be, and IE 11 is actually very competitive in some benchmarks, such as JavaScript performance, where it blows away the competition.

Still, for most common browsing, you're going to see a speed increase if you switch from IE to Chrome or Firefox. Chrome is arguably the fastest of the bunch overall, but it's also noticeably more system resource intensive than Firefox, so if you're trying to speed up an old PC, the latter might be a better choice.

16 MICROSOFT WORD

Microsoft Word is the industry standard for text editing, but its expansive feature set comes at a hefty price to your system's resources. Ask yourself if you really need everything that Word has to offer, and if you wouldn't be better off using an alternative.

If you need a full-featured word processor with a smaller footprint, you can try Writer, part of the LibreOffice suite of free Office replacement applications. It offers nearly all the features of Word, with a much lighter set of system requirements. If you want to do some very light writing or note taking, consider the WordPad app that comes installed with Windows—it's low on features, but very fast.

17 PHOTOSHOP

Adobe's Photoshop is another widely-used app that can put a major strain on your system resources. If you're using an older system that's not up to running Photoshop CC (or if you just want to save a lot of cash), check out GIMP (www.gimp.org). It's an open-source image editor that can do almost everything Photoshop can. The interface is a little clunky and has a steepish learning curve, but GIMP will run much better on old PCs than newer versions of Photoshop.

18 ADOBE READER

Not to spend too much time harping on about Adobe, but the basic PDF Reader is one of the slowest, most frustrating pieces of software on your computer. You wouldn't think something as simple as displaying a multimedia document (which your browser does in fractions of a second) would be slow and require a bulky install—and it doesn't have to.

To reclaim lost speed, install the alternative, a free version of Foxit reader (http://bit.ly/1D9SjfT). It has a nice interface, takes up very little disk space, and runs faster than your chunky old Adobe Reader.

19 REPLACE WINDOWS MEDIA PLAYER WITH VLC

Speed is only one of the many reasons to replace the default Windows Media Player with a different application, such as the excellent VLC (www.videolan.org). Though VLC is quicker to start playback on media files, the real time savings come from the app's flexibility. Watching a video in other players can be a stop-and-go experience involving tracking down codecs or differently formatted media files. With VLC, you know most any file will just work, and it'll work fast.

EVEN MORE SOFTWARE TWEAKS

20 HAND-TUNE GRAPHICS SETTINGS IN GAMES

If you're experiencing slowdown in games, make sure you're taking advantage of customization options available in the preferences menu. Lowering resolution is the obvious way to get better performance, but make sure you're looking at other options as well—turning down antialiasing or shadow quality can make a huge difference.

21 CUSTOMIZE YOUR GRAPHICS SETTINGS AUTOMATICALLY

Try out GeForce Experience (for NVIDIA GPUs) or AMD Gaming Evolved, both of which automatically tweak game settings. They profile your hardware, then consult a constantly refined database of hardware data to suggest optimum settings, without any trial and error.

22 LEARN TO LOVE JUMPLISTS

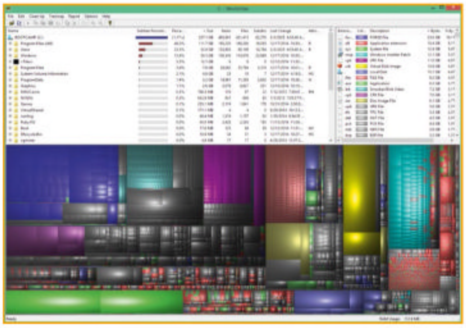
Introduced in Windows 7, jumplists are a fast way to access recent or frequently used documents or features of programs. Instead of left-clicking on an icon to open it, right-click on it instead—you'll see a context-sensitive list of shortcuts or documents for that program.

23 FREE UP DISK SPACE

Freeing up hard drive space won't always make your computer faster, but it can make a big difference if your drives are almost at capacity. If you're having a hard time figuring out what to delete, use a free drive visualizer such as WinDirStat (windirstat.info) to pinpoint greedy programs and docs.

24 CLEAR UP UNNECESSARY BROWSER EXTENSIONS

It's great how extendable modern browsers are, but it's easy to slow down your web browsing by installing too



If you're unsure what to delete from your hard drive, WinDirStat will help.

folders. *42* Minimize everything in a hurry Press WIN + M to minimize every open window straight away. *43* Open a command
this location. *44* Switch to full screen and back If you like to switch in and out of full-screen view in your web browser, use F11

many add-ons and extensions. Go into the settings for your browser, and make sure you actually use any active extensions. If you have a toolbar that you can't figure out how to uninstall, try CCleaner, described on page 41.

25 INSTALL AN AD-BLOCKER

Not every extension slows down your browser. A good ad blocker (like AdBlock or AdBlock Plus) will speed up your browsing a lot, by preventing web ads from loading. Just search for "AdBlock," plus the name of your preferred browser—it's free and installs in seconds.

26 SPEED UP YOUR FILE SELECTION WITH SELECT-INVERSE

If you've ever found yourself trying to select all but a few files in a large list, you know it can be an exercise in tedium and frustration. Rather than wearing your left-click button out, try this neat trick: Just hold Control and select the files you *don't* want, then click on "Invert Selection" in the options menu.

27 INSTALL EVERYTHING FOR FASTER SEARCHES

Windows search has gotten a lot faster over the years, but it can still be slow, particularly if you're searching for a file outside the User folder. For near-instant searching through every file on your PC, download the free program Everything from www.voidtools.com.

28 LAUNCH ANOTHER INSTANCE FAST WITH SHIFT-CLICK

There's a fast way to open up a second window or document in a program that supports multiple simultaneous instances (like your web browser, or Microsoft Word). Instead of manually creating a new doc, just hold down the Shift key and click on the taskbar icon for the program. Clicking the middle mouse button will do the same thing.

29 SET UP YOUR FAVORITE FOLDERS

A lot of users overlook one of the handiest features in the File Explorer: the favorite locations list in the upper left. If you find yourself frequently navigating to the same file location, save it to the Favorites for easy access. All you have to do is drag the folder to the Favorites area, and it'll be saved forever.

OVERCLOCKING

Become an expert in getting the most out of your hardware

If you've never done it before, overclocking might seem like black magic. The practitioner delves into the shadowy, mysterious world of the BIOS, tweaks some arcane symbols, and when they resurface, the PC is somehow faster.

But the truth is, anyone with the right hardware can overclock with just a little patience. Here we'll talk about overclocking every part of your PC, from the CPU to the GPU to the RAM.

We should mention that the guides presented in this section are very cursory—there's just not enough space to really get into the details of the overclocking procedure. That said, we've tried to give you a good idea of the basic process involved. There's a ton of information about overclocking available online, and we encourage you to search for info pertaining to your specific hardware before jumping in.

If you follow these procedures you're very unlikely to damage your hardware, but a component-specific guide can reduce the guesswork required.

CPU

Before we get into the process, we should point out that only certain CPUs can be overclocked, so you should do a search to see if you have an "unlocked" processor. The basic rule for recent Intel processors is that CPUs with model numbers ending in the letter "K" are unlocked.

30 PROCESSOR OC'ING

For space purposes this guide will only discuss Intel CPUs, but the basic process is the same for AMD chips. You'll also need a motherboard with overclocking capabilities. The Intel mobos with model numbers starting with "Z" are overclocking-ready, but for other brands you'll have to search to find out if yours can overclock. Finally, for all but the smallest overclocks, you will almost certainly want an aftermarket CPU cooler.

STEP 1
GET READY

There are several apps you need while you overclock your CPU. First, you'll need CPU-Z (http://bit.ly/QhR6xF), an application which allows you to view detailed information about your CPU from within Windows. The actual overclocking will be done in the BIOS, but CPU-Z will let you make sure your settings are properly applied during testing. You'll also need RealTemp (http://bit.ly/JBWaJA), which shows you your CPU temperature, and Prime95 (http://bit.ly/1kVNJZh), to stress-test the CPU.

Once you've installed the necessary software, reboot and press whatever keys are required to get into your motherboard's BIOS. If you don't know those keys and it doesn't say during the boot sequence, you'll have to do a web search.

STEP 2
ADJUST THE MULTIPLIER

Once in the BIOS, you'll need to find the settings menu for adjusting CPU performance. This will probably be easier if you search for documentation about your particular motherboard, but you can also just look for the menu that features options like "baseclock," "core voltage," and "CPU Ratio." That last option is what we want to increase. Upping the CPU Ratio by one (from 34 to 35, for instance), increases the final clock speed of the CPU by 0.1GHz (from 3.4GHz to 3.5GHz). To successfully overclock the CPU, we'll increase this multiplier by one, save, and reboot the OS.

STEP 3 TEST AND ADJUST VOLTAGES

Now that we've performed a small overclock, we need to make sure everything's still working. In Windows, launch CPU-Z and check the ratio (also called a "multiplier") is what you set it to. Next, load up RealTemp and then run Prime95, while watching your core temperature. If your CPU temperature rises above 80 C, then your overclock is unstable and may degrade your CPU—you'll have to

to do it quick. 45 Open the Run menu fast The Run dialog option lets you open almost anything. Get there fast with WIN + R. Send Windows to the sides of the screen To quickly snap windows to either side of the screen in Windows 7 and 8, hold WIN

Intel CPUs with model numbers ending in the letter "K" are unlocked.

boot back into the BIOS and return the multiplier to its previous setting. On the first test, this shouldn't be the case. Alternatively, Prime95 might throw up an error, or your computer might crash. If that happens, your voltage is too low.

STEP 4 ADJUST VOLTAGES AND REPEAT

Whatever happens, restart your PC and boot back into the BIOS. If you had no issues whatsoever, just increase the multiplier by one more and go back to Step 3. If you experienced a glitch or a crash, you need to crank up the CPU voltage, so increment that value by .05. It's a good idea to do a search for the maximum safe voltage for your particular CPU. Return to Step 3 and repeat the process, increasing the multiplier when possible and voltage as needed, until your temperature gets too high or you approach the maximum safe voltage.

GPU

For a gaming PC, your GPU performance may well be more important than your processor's. Most modern games are GPU-bound, so eking a little more performance out of your GPU will have a more dramatic effect on your gaming experience than a similar improvement in the CPU.

Overclocking your graphics card will have the biggest effect on gaming.

31 MORE GRAPHICS GRUNT

Fortunately, basic GPU overclocking has become incredibly simple in recent years, thanks to very user-friendly overclocking tools that do most of the heavy lifting for you.

If you have an NVIDIA card, grab EVGA PrecisionX from www.evga.com/precision/ (note it doesn't have to be an EVGA card), or if your card is AMD you can actually overclock it directly from the Catalyst Control Centre.

STEP 1 BENCHMARK

Before you begin, you'll need to download a suitable benchmark, which serves two purposes. First, it will allow you to quantify your computer's graphics performance, so you can tell how much of a difference your overclocking actually makes. Second, running the benchmark acts as a stress-test on your graphics card, so that as you tweak your overclock settings you'll quickly see if you've pushed things too far.

Visit unigine.com/products/heaven/ to download Heaven, the current standard for graphics benchmarks. Set a baseline by running through it once at full-screen resolution. Record your results.

STEP 2 MEMORY

In your overclocking software, you'll see sliders for power limit, memory clock and core clock. We'd adjust all of these, starting with the power limit. Simply set it as high as it will go.

Next, we'll overclock your graphics card's RAM. All you have to do is run the Heaven benchmark in a window, and gradually start increasing the memory clock setting until you see glitches or visual artifacts in the benchmark. Increase the memory clock in increments of 5-10MHz. If you go too high too fast you might crash the system (though it will be fine after a reset).

STEP 3 GPU

After you've found the sweet spot for your memory clock, set it back to default and shift your focus to the core clock. Again, up the clockspeed in small increments, until the Heaven benchmark starts to show the strain. The telltale visual artifacts can take a number of forms, including colored blobs, full-screen flashes or stray pixels. When they start to appear, dial the GPU clock back until the benchmark is once again stable. Also keep an eye on the temperature of your graphics card. Even if no visual artifacts appear, you'll want to keep the average GPU temperature below 80 C, or you'll wear your expensive chip out much faster.

STEP 4 ENSURE IT'S STABLE

Once you've found the ideal overclock for both the video memory and the GPU, you're ready to activate both at the same time and run the benchmark in full screen again. There's a good chance that with both active you'll see new artefacts or your PC will crash. If that happens, just tweak both overclocks down by a small increment and keep trying to run the tests.

Even if your benchmark is stable for now, there's a chance it will overheat during longer sessions. We recommend you loop the Heaven benchmark for 15-20 minutes to make sure that this isn't the case.

MEMORY OVERCLOCKING

Is it worth it?

It's possible to overclock your memory if you have the right hardware, but it's much less commonly done than CPU or GPU overclocking. So, should you overclock your RAM? In our opinion, no.

The reason we don't recommend overclocking RAM is a simple cost-benefit analysis. The cost, like with any overclock, is in stability. Especially with an aggressive overclock, you run the risk of wearing your part out prematurely, or of making it unstable and causing system crashes. The GPU can recover from a glitch without crashing the whole system, but not your RAM. Also, because RAM overclocking isn't quite as common, there are fewer resources available to help you.

On the flip side, the benefits to overclocking your RAM just aren't very substantial. Overclocked RAM has faster throughput, but memory throughput is almost never a bottleneck, and will have a negligible effect on gaming performance. The risks of overclocking memory aren't huge, but there's just not much reason to do it.

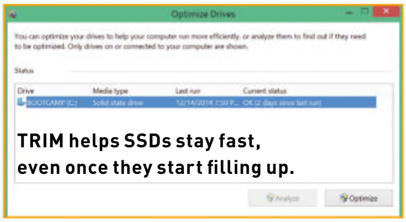
46 Open the Users folder from Run With the Run dialog open, enter two periods then press Enter to open your Users folder. 47 and press the left or right arrow keys. 48 Lock in a hurry Throw up the windows lock screen immediately by pressing WIN

MORE HARDWARE TWEAKS

Five more ways to get your PC back to its speedy best

32 DEFRAG HDDS

One of the oldest computer tricks in the book, defragging your hard drive isn't quite the performance booster it used to be. For one, more and more computers now come with SSDs, which do not benefit from defragging. Also, Windows 7 and 8 defragment on an automatic schedule, so it's unlikely your drives are fragmented if you use one of those systems. On older versions of Windows, fragmentation can still slow your hard drives down, so it's worth running a disk defragmentation program, such as the built in Windows Dfrg.msc or the free Defraggler (www.piriform.com/defraggler).



You can optimize your drives to help your computer run more efficiently, or analyze them to find out if they need to be optimized. Only drives on or connected to your computer are shown.

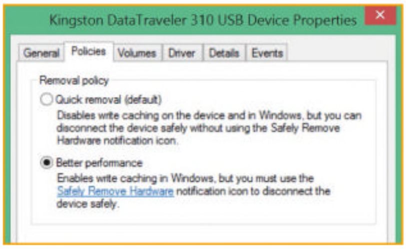
Status

Drive	Media type	Last run	Current status
BOOTCAMP (C:)	Solid state drive	12/14/2014 7:50 P...	OK (2 days since last run)

TRIM helps SSDs stay fast, even once they start filling up.

33 KEEP IT TRIM

SSDs don't need to be defragged, but there is one optimization that can make a big difference, called TRIM support. TRIM prevents an SSD from slowing down as it gets filled with data, and increases its expected life span.



Removal policy

○ Quick removal (default)
Disables write caching on the device and in Windows, but you can disconnect the device safely without using the Safely Remove Hardware notification icon.

● Better performance
Enables write caching in Windows, but you must use the Safely Remove Hardware notification icon to disconnect the device safely.

You can speed up your USB drive, as long as you remember to safely remove it.

The good (or bad) news is that Windows 7 and 8 automatically enable TRIM for SSDs, so you won't be able to get a speed boost there. However, if you're running Windows XP or Vista, it's definitely worth enabling it. To do this, you'll have to use the third-party management software available from the manufacturer of your SSD.

34 CLEAN OUT FANS

Not every problem that slows your PC is a high-tech one. Old-fashioned dirt and dust can build up, blocking fans and vents. It may seem trivial, but a jammed vent can cause your PC to overheat and chug. Airflow obstructions are especially likely in homes with hairy pets. In the worst cases, high heat will cause your components to degrade faster. Get in there with a can of compressed air and make sure nothing's blocking your vents, fans or the fins of your CPU cooler.

35 ADJUST USB STORAGE FOR BETTER PERFORMANCE

If you have an external USB drive you frequently transfer data to or from, you can get a small speed boost by disabling write caching on the drive. The drawback is that write caching protects USB drives from data loss if they're removed in the midst of a transfer. If you're willing to make sure to press the "safely remove drive" button every time, you can improve performance by opening the Device Manager, navigating to the drive, then right-clicking it and opening the Properties menu. In the Policies tab, click "Better Performance."

36 RUN A SMART TEST

Hard drive failure is one of the most alarming things. Even with a back-up strategy (which you have, right?) the temporary loss of your data is a major inconvenience. Save yourself some time down the line by running a SMART test on your hard drive—a process that will help you identify soon-to-fail drives. Just download a free SMART diagnostic tool like CrystalDiskCheck (http://bit.ly/TKZ1VK), and run it to test your drive. If the drive fails any of the tests, it's time to get a new one.

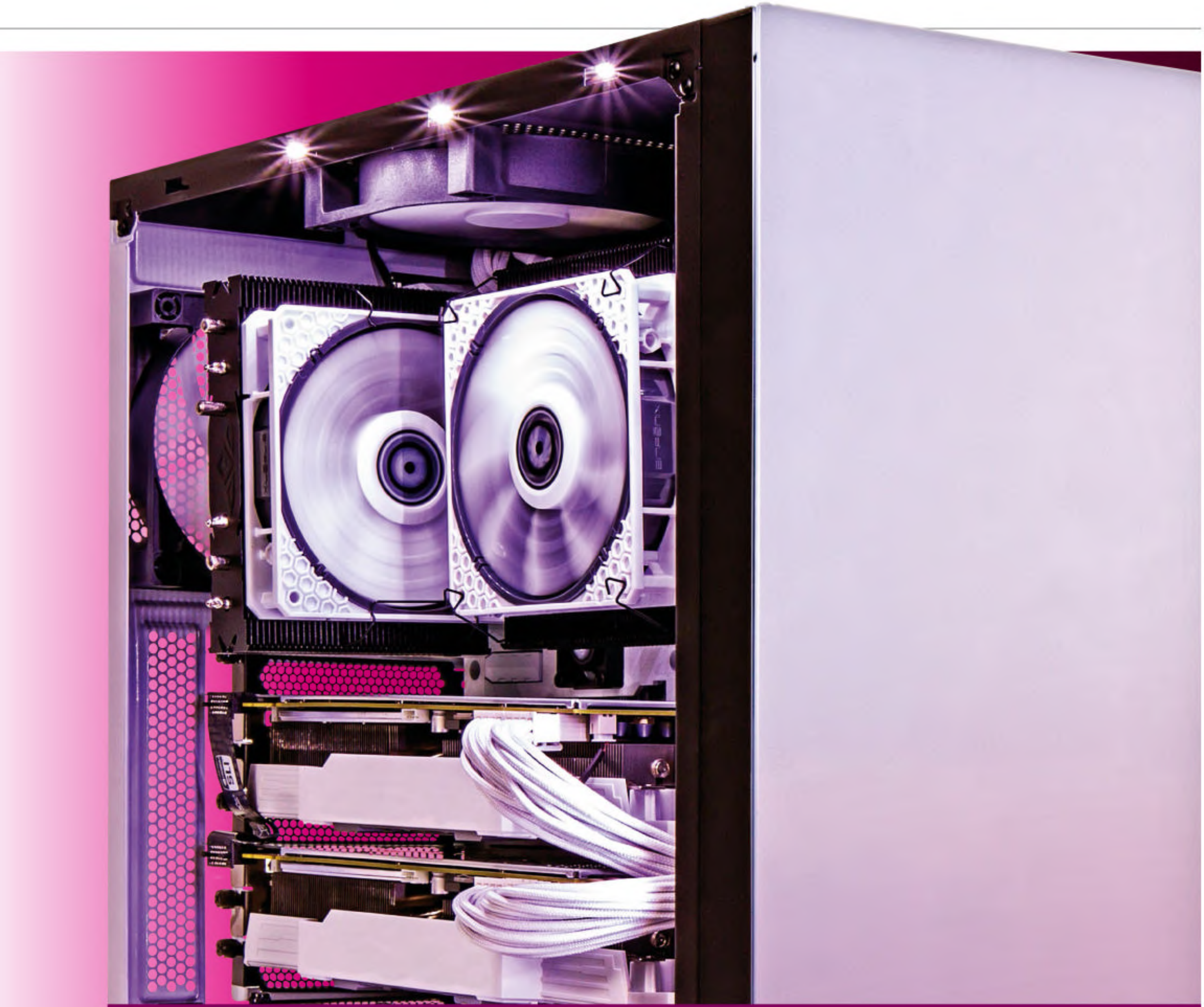
ALL IS LOST When to admit defeat

So far in this article, we've taken the generally optimistic stance that every computer can be sped up with nothing more than a little bit of elbow grease. And while it's true that it's very hard to mess up your PC so badly you can't fix it, it's not impossible. It's easier still to get into a situation where repairing the damage is going to be more work than just starting fresh, and knowing when this is the case will save you a lot of time. Here are our standards for when to throw in the towel.

A bad virus infection: A lot of malware can be easily removed using a tool such as Malwarebyte Anti-Malware, but sometimes an infection is just too bad to fix. Don't worry, you'll know it when you run into a PC like this—the Malware scanner will have a red flag list that's hundreds of items long, and includes viruses and other more malicious software. You don't want to risk clearing out most of the malware while probably leaving only the most sophisticated and dastardly to carry on running in secret.

When upgrading to a new version of Windows: When you're ready to move on to the latest, greatest version of Windows, it's worth doing a clean install. Microsoft gives you the option to do an "in-place" install, keeping your files intact, but in our experience it's not worth it. Follow proper backup procedures and start over with a nice, clean Windows installation. You won't have to worry about any complications from the in-place upgrade, and it will give you an opportunity to re-evaluate which programs you really need installed.

A Windows XP computer: We know, some of you still love Windows XP very much, but it's simply time to upgrade to a more modern OS. It's not worth trying to speed up a Windows XP PC, because even if you get it to like-new condition, you'll still have a computer that's not secure.



THE FINAL WORD

Stay lean, get mean, and keep it clean

If you've made it through all the tips in this article, you've probably noticed that none of the steps individually are that big or difficult. Instead, what it really comes down to is cultivating a set of habits that keep your PC organized and efficient. To try and contextualize it a little more, here's a big picture look at how to keep your PC running as fast as it can.

On the hardware level, basic maintenance is all you really need. There are a few tweaks to be made, but as long as you keep your system physically clean and occasionally run a test to check the integrity of your hard drives, you'll be fine. You can get a significant speed boost by overclocking your hardware, but only if it's a good component to begin with.

There are lots of ways to improve your system at the OS and software level, but they basically boil down to a few central principles. For one, try and keep things lean. The more software you install, the more things start up with your PC. The fuller your hard drives are, the slower your computer's going to run. Don't stress about every little thing you install, but if you can delete a few programs every now and then your computer will be better off. Similarly, consider replacing some of your more heavy-duty programs with lightweight ones, if you don't need all the features of the former.

Finally, you have to acknowledge that sometimes the best thing you can do is to just start fresh. We described when you should reinstall, the best way to do it, and even how you can start again with a whole new operating system. Hopefully your computer isn't at that stage yet, and you'll be able to put some of the tips from the last 10 pages to good use. ⏻

Shift + Tab to go back. *50* Search Windows 8 immediately The fastest way to search for something in Windows 8 is to press the

recently closed tab back. *52* Quick zoom Zoom on webpages or documents by holding Control and scrolling the mouse wheel.

HOW TO

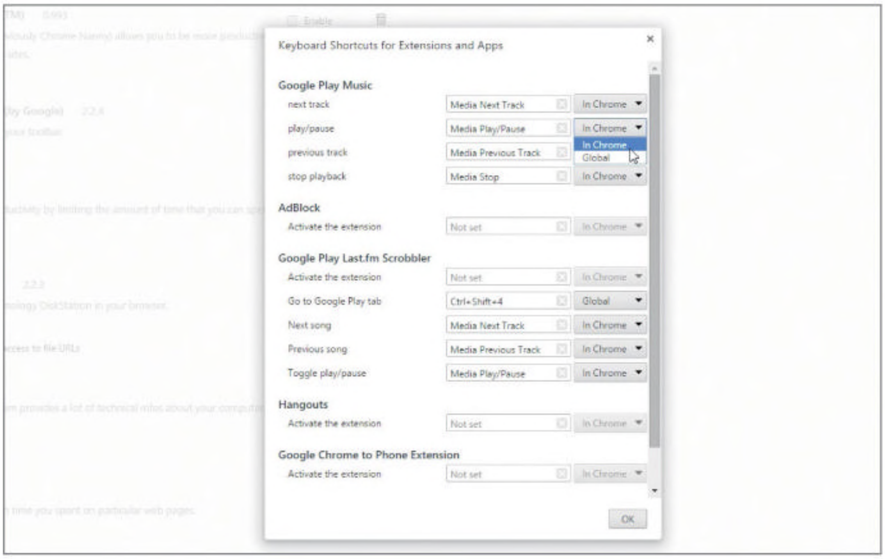
STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

GRAHAM BARLOW
CONTRIBUTING EDITOR

MAKE YOUR PC YOUR OWN!

One of the reasons we love PCs so much is that if you don't like something, you can just change it. In this section we present a great collection of guides for really mixing things up in Windows and getting even more out of what you've already got. Thanks to some useful (and totally free) add-on programs, you'll be able to give your PC a rad new look! We've also got some invaluable troubleshooting advice on what to do if your PC won't turn on, and how to handle the excesses of an ultra-widescreen monitor.

A HANDY WINDOWS TIP



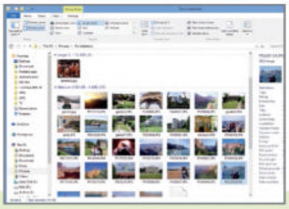
Keyboard Shortcuts for Extensions and Apps

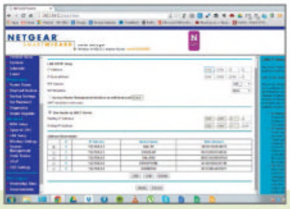
Google Play Music		
next track	Media Next Track	In Chrome
play/pause	Media Play/Pause	In Chrome In Chrome Global
previous track	Media Previous Track	
stop playback	Media Stop	In Chrome
AdBlock		
Activate the extension	Not set	In Chrome
Google Play Last.fm Scrobbler		
Activate the extension	Not set	In Chrome
Go to Google Play tab	Ctrl+Shift+4	Global
Next song	Media Next Track	In Chrome
Previous song	Media Previous Track	In Chrome
Toggle play/pause	Media Play/Pause	In Chrome
Hangouts		
Activate the extension	Not set	In Chrome
Google Chrome to Phone Extension		
Activate the extension	Not set	In Chrome

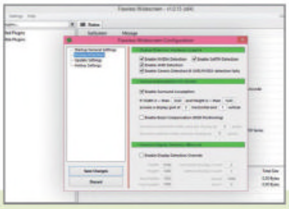
TAKE CONTROL OF YOUR MEDIA KEYS

If you've got the Chrome browser installed, your keyboard's media keys might not work, due to them being hijacked to only work with Google's Play Music. It's easy to fix. Open Chrome, click the menu icon in the upper right, choose "More tools," then "Extensions." Click "Keyboard shortcuts" and change the Google Play Music settings from "Global" to "In Chrome."

MAKE – USE – CREATE







82 Take control of File Explorer

84 Secure your Windows 8.1 PC

86 Make your desktop a thing of beauty

88 Overclock your GPU with ease

91 Secure your Wireless Network

92 Getting past the POST

95 Fix your ultra-widescreen woes

96 Customize Windows 8.1

↘ submit your How To project idea to: comments@maximumpc.com

Configure Your Second Display

YOU'LL NEED THIS

SECOND SCREEN
Whether it's a laptop, monitor, or TV, it should be easy to connect with either HDMI or VGA.

LIKE IT OR NOT, the most ergonomic way of using a laptop is to sit at a proper desk with a proper monitor, mouse, and keyboard. There are other advantages to this setup, as well; you can use your original laptop display as a second screen. Dual-screen setups are now the norm in many offices, and you can have the same at home as well. It's useful for copying information between documents, having your email on one screen while you work on the other, editing photos on one screen while you have your photo library on the other, and so on. Here we'll set up Windows to function with a second screen and configure the two screens to be set up the way you want. Likewise, this tutorial will also help you if you have a work laptop that you often plug into different screens, perhaps in meeting rooms or out on the road. **–DAN GRABHAM**

1 GO TO THE DISPLAY CHARM

Once you've physically connected your main display (via HDMI or VGA), your second screen will show the same as your first screen or it will be blank. You may want the same thing on both screens, but we're going to extend the desktop. In Windows 8 or 8.1, push your mouse to the right-hand side of the screen to show the Charms menu. Select "Devices."

2 PROJECT YOUR SCREEN

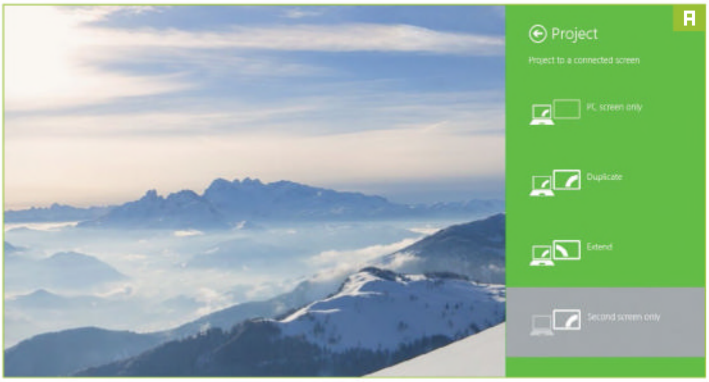
The Devices menu shows three options: Play, Print, and Project. Select "Project." This is the option to choose whatever type of display you're throwing your screen image to, whether it's a projector, monitor, or TV. You'll then see the next screen, which shows four display options. During this process, your main screen may flicker on and off.

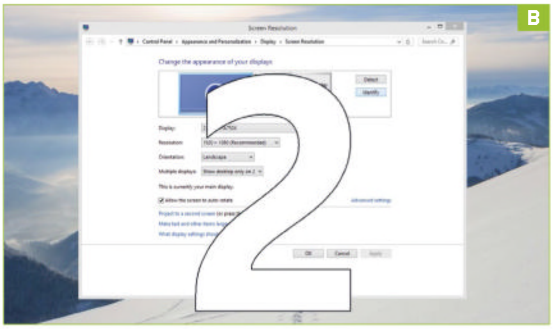
3 CHOOSE YOUR MODE

You're probably currently in Duplicate mode, but "Extend" is a better option. It enables you to extend your desktop across multiple screens. In Windows 8.1, you can have different Windows apps on the two displays. "PC screen only" turns off the signal to your second display and "Second screen only" does the opposite [**Image A**]. It's ideal for saving power on your laptop, for example.

4 CONFIRM YOUR CHOICE

We've chosen to use the second screen only. Windows will ask you to confirm. That's because there's a risk with some options you might not be able to see anything. This is a failsafe in case your main display is turned off and there's a problem with your second display. If you don't click "Yes" to confirm this option, Windows will revert to your previous display.




B
Screen Resolution
Control Panel › Appearance and Personalization › Display › Screen Resolution
Change the appearance of your displays
Detect
Identify
2
Display:
Resolution:
Orientation:
Landscape
Multiple displays:
This is currently your main display.
Advanced settings
OK
Cancel
Apply

5 CONTROL PANEL ALTERNATIVE

You're able to perform these same actions (and more) using the Display applet. The way this works is similar to how it works in Windows 7, Vista, and XP, though some refinements have been made in Windows 8 and Windows 8.1. Navigate to it by going to "Control Panel → Appearance and Personalization → Display," and clicking on "Adjust screen resolution."

6 TOGGLE BETWEEN DISPLAYS

The Display applet features a graphical representation of the screens connected to your PC, plus some options. Here you can toggle between two connected displays. You can also change the resolution—your PC will normally automatically adjust this to suit—as well as the orientation of the desktop in case you rotate your monitor.

7 IDENTIFY YOUR DISPLAYS

If you've lost track of which display is which, click "Identify." You'll see a number on each screen [**Image B**]. Using the graphic, you can also drag the displays around so Windows knows where they are in relation to each other. It needs to know this in case you extend the desktop—if you drag the mouse off one screen, you want it to appear in the right place on the screen next to it! If your computer hasn't found your display, click "Detect." There are then options to adjust each display however you'd like.

Take Control of File Explorer

YOU'LL NEED THIS

WINDOWS 8.1
File Explorer is a revamped Windows Explorer. It revolutionizes how you manage files and folders.

WINDOWS 8.1'S FILE EXPLORER is more than just a rebadged version of Windows Explorer. It's a revelation. Thanks to a raft of improvements and new features, it makes managing your files easier than ever. There's the improved file copying tool, which not only speeds up file transfers, but makes them easier to manage, too. The new ribbon-based UI places all the key tools you need within easy reach, and the Navigation pane remains a great way to quickly move to the different parts of your PC.

In this tutorial, we'll reveal File Explorer's best features, some of which are hidden away from view. We'll also show you how to make File Explorer even more useful by customizing it to your personal requirements. You'll be working smarter before you know it! –**NICK PEERS**

1 CUSTOMIZE NAVIGATION PANE

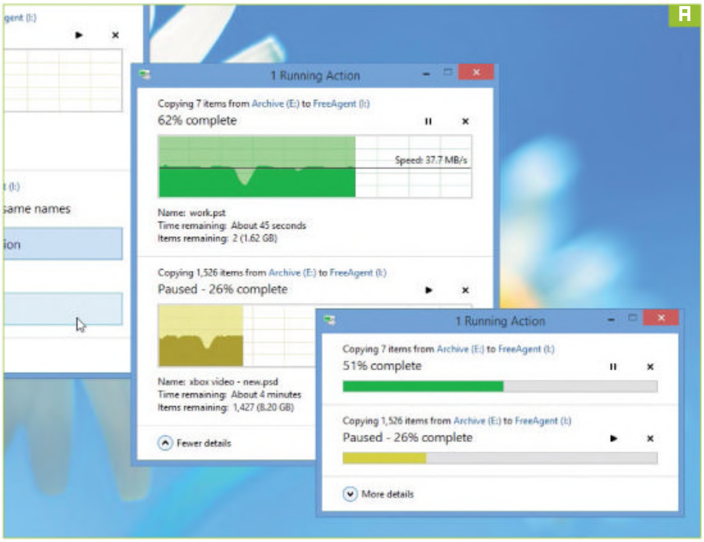
Click the "File Explorer" button on the Taskbar to open a File Explorer window. The Navigation pane on the left is designed to put frequently accessed folders and drives at your fingertips. Click "Navigation" on the "View" tab to show or hide the Favorites list, plus restore the Libraries view. Choose "Show all folders" to unite all other lists under a single Desktop view.

2 QUICK-FIRE SELECTIONS

When the "Item check boxes" box is ticked on the "View" tab, selecting a file or folder results in a box being ticked. You can choose one of two ways: Roll the mouse over an item and then click the tick box that appears, or use the old Ctrl–click method to quickly choose a host of files. Either way, it's a more elegant way of making multiple selections.

3 QUICKLY MOVE AND COPY FILES

You can, if you prefer, open two File Explorer windows (select "Open new window" on the "File" tab) for moving or copying files, but why not try this shortcut? Navigate to the "Home" tab where you'll find two buttons: "Move to" and "Copy to." Click either button to access a list of frequently used locations, or browse for a specific folder.

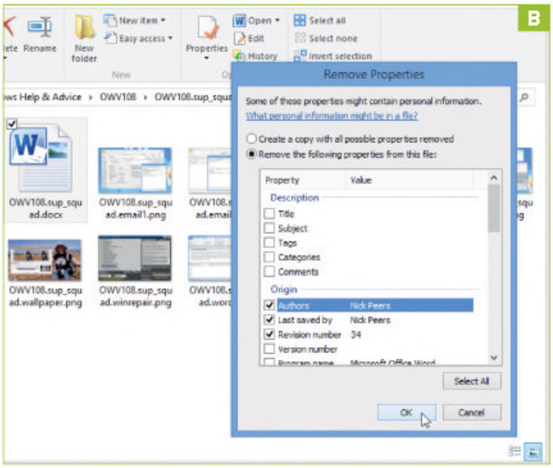


Copying 7 items from Archive (E:) to FreeAgent (I:)
62% complete
Speed: 37.7 MB/s
Name: work.pst
Time remaining: About 45 seconds
Items remaining: 2 (1.62 GB)

Copying 1,526 items from Archive (E:) to FreeAgent (I:)
Paused - 26% complete
Name: xbox video - new.psd
Time remaining: About 4 minutes
Items remaining: 1,427 (8.20 GB)

Copying 7 items from Archive (E:) to FreeAgent (I:)
51% complete

Copying 1,526 items from Archive (E:) to FreeAgent (I:)
Paused - 26% complete



Remove Properties

Some of these properties might contain personal information.
What personal information might be in a file?

○ Create a copy with all possible properties removed
● Remove the following properties from this file:

Property	Value
Description	
☐ Title	
☐ Subject	
☐ Tags	
☐ Categories	
☐ Comments	
Origin	
☑ Authors	Nick Peers
☑ Last saved by	Nick Peers
☑ Revision number	34
☐ Version number	
☐ Program name	Microsoft Office Word

4 FASTER, IMPROVED COPYING

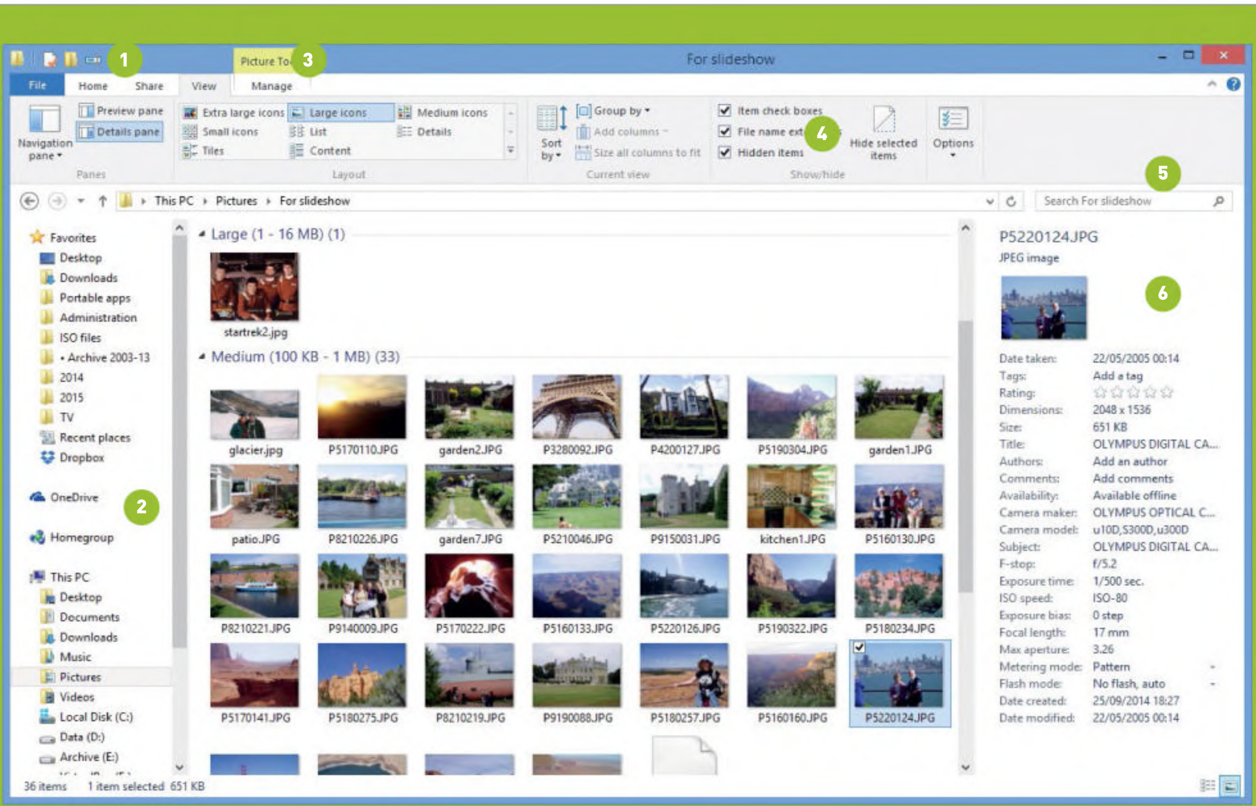
When files are being moved or copied, a new dialog provides more options, particularly when you may need to replace (or ignore) existing files. During the copy process, click the expand button to see the file transfer speeds. The new dialog also allows you to pause and resume transfers—handy when you want to suspend a large transfer operation temporarily **[Image A]**.

5 EDIT FILE PROPERTIES

Want to share a file without including all that private metadata such as its author? Select the file, then click the arrow beneath the Properties button on the Home tab, and choose "Remove properties." You can create a separate copy stripped of personal information, or select which properties to remove from the file itself—click "OK" when done **[Image B]**.

6 ROLL BACK FILES

Need access to an older version of a file? Select the file or folder in question, then click the "History" button on the Home tab. Right-click the file and choose "Preview," then use the playback controls at the bottom to locate the version you want to restore. Click the "Restore" button to overwrite the original file, or click "Settings → Restore to" to save a separate copy instead.


1
2
3
4
5
6
For slideshow
Picture Tools
File
Home
Share
View
Manage
Preview pane
Details pane
Navigation pane
Extra large icons
Large icons
Medium icons
Small icons
List
Details
Tiles
Content
Sort by
Group by
Add columns
Size all columns to fit
Item check boxes
File name extensions
Hidden items
Hide selected items
Options
This PC › Pictures › For slideshow
Search For slideshow
Large (1 - 16 MB) (1)
Medium (100 KB - 1 MB) (33)
36 items 1 item selected 651 KB

P5220124.JPG
JPEG image

Date taken: 22/05/2005 00:14
Tags: Add a tag
Rating: ☆☆☆☆☆
Dimensions: 2048 x 1536
Size: 651 KB
Title: OLYMPUS DIGITAL CA...
Authors: Add an author
Comments: Add comments
Availability: Available offline
Camera maker: OLYMPUS OPTICAL C...
Camera model: u10D,S300D,u300D
Subject: OLYMPUS DIGITAL CA...
F-stop: f/5.2
Exposure time: 1/500 sec.
ISO speed: ISO-80
Exposure bias: 0 step
Focal length: 17 mm
Max aperture: 3.26
Metering mode: Pattern
Flash mode: No flash, auto
Date created: 25/09/2014 18:27
Date modified: 22/05/2005 00:14

UNDER NEW MANAGEMENT

1. QUICK ACCESS TOOLBAR
Add any File Explorer button you like here for quick access. Up to six options are provided by default.

2. NAVIGATION PANE
Use the Home tab's Easy access button to add your most-used folders to the Favorites section for quick access.

3. CONTEXT-SENSITIVE TABS
These tabs appear when certain items are present. Click a file or folder to access context-sensitive controls.

4. VIEW TAB
Use the View tab to set up how the current folder looks and behaves. Changes will only apply to this folder.

5. SEARCH
Type search terms here to look through the current folder. Use the ribbon's Search tab to fine-tune the results.

6. DETAILS PANE
Selecting this and clicking a file or folder reveals its details without having to manually open its Properties box.

7 CUSTOMIZE SEARCHES

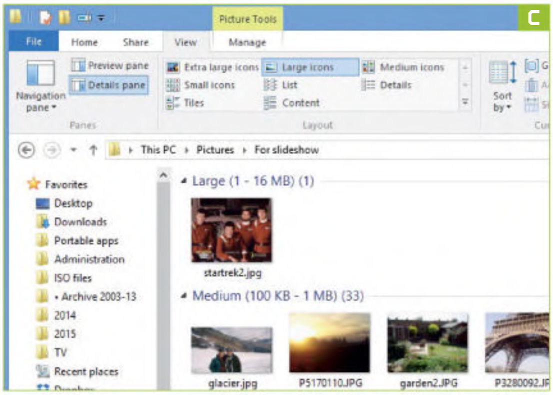
Enter your search terms into the Search box and hit Enter—a new Search Tools tab will appear. Use this to change the location of the search, plus refine the search terms using filters such as type of file, size, and when it was last modified. You can also access recent searches, change which folders are indexed via the "Advanced options" button, and save your search.

8 SHARING OPTIONS

The Share tab contains more than just the usual options. This is where you go when you want to burn selected files to disc, print or fax them, add them as an attachment to an email, or compress them into a Zip file. An "Advanced security" button is also here if you need to fine-tune access permissions.

9 QUICK ACCESS TOOLBAR

You can add any File Explorer item you'd like to the Quick Access Toolbar by right-clicking its button and then choosing "Add to Quick Access Toolbar." There's space to display up to seven items above the ribbon on the Toolbar. Alternatively, you can click the "Customize" button and choose "Show below the ribbon" to give it some more room. Manage the Toolbar by right-clicking unwanted items and choosing the "Remove" option.


C
Picture Tools
File
Home
Share
View
Manage
Preview pane
Details pane
Navigation pane
Extra large icons
Large icons
Medium icons
Small icons
List
Details
Tiles
Content
Sort by
This PC › Pictures › For slideshow
Large (1 - 16 MB) (1)
Medium (100 KB - 1 MB) (33)

10 HIDE THE RIBBON

The ribbon user interface at the top displays a series of toolbars in separate tabs, instead of a more traditional menu-based system. If it's not to your taste, click the ^ button in the top right-hand corner. That hides everything except the tabs and the Quick Access Toolbar. Click a heading to view the options for that tab—when you click away from the ribbon it'll disappear. Restore it by hitting the down arrow button [Image C].

Secure Your Windows 8.1 PC

YOU'LL NEED THIS

MALWAREBYTES
The anti-malware scanner is available, for free, from www.malwarebytes.org.

MICROSOFT HAS SPENT a lot of time and effort improving the security mechanisms in its OSes, and Windows 8.1 builds on previous releases to protect you against malicious software, such as viruses, spyware, and other nasties. Microsoft's Trustworthy Computing team has outlined the improvements in Win8.1, and broken them down into four categories: trustworthy hardware, modern access control, protecting sensitive data, and malware resistance. The first three are focused on enterprise users, and are geared towards BYOD (Bring Your Own Device) scenarios.

The good news for home users is that Microsoft is also beefing up its built-in malware resistance. For one, Internet Explorer 11 ships with the Enhanced Protection Mode enabled by default, which is designed to safeguard your data even if an attacker has managed to compromise the browser or one of its add-ons. Secondly, Microsoft has also improved its built-in Windows Defender tool. Read on to discover how to make the most of it. **–GRAHAM BARLOW**

1 USING WINDOWS DEFENDER

Windows Defender was upgraded to become a full antivirus program with the release of Windows 8. To bring up the program, type "defender" on the Windows 8.1 Start screen. The colored bar at the top of the Windows Defender interface reflects the protection status of your computer.

» You will see big red warnings if the program has been turned off, or if your database is out of date, while Windows Defender keeps itself updated by automatically downloading new updates to its virus database.

2 STARTING A TAB

The main Windows Defender interface lists four tabs. From the "Home" tab, you can run a quick scan or a full scan by selecting the appropriate button and clicking "Scan now." Alternatively, with the "Custom" button, you can scan specific drives, directories, or even individual files.

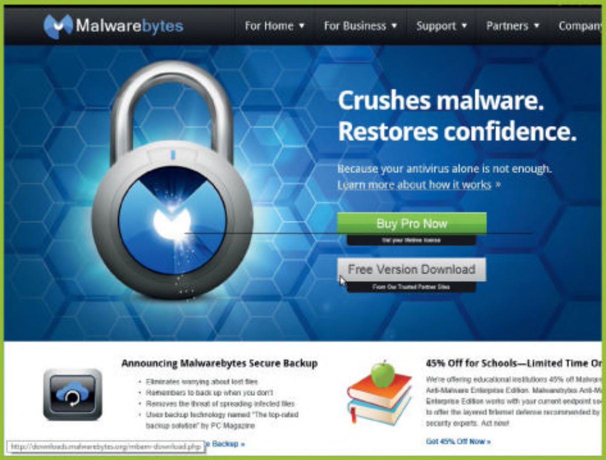
3 GOING INTO QUARANTINE

If Windows Defender finds something objectionable, it moves it into a quarantined area. To view these items, switch to the "History" tab, select the "Quarantined items" radio button and click the "View details" button. This brings up a list of programs that Windows Defender has taken action on, along with the alert level, and the date. From here you can choose to "Remove all quarantined items," or remove them selectively.

4 GETTING OUT OF QUARANTINE

Sometimes Windows Defender might accidentally quarantine a harmless program. In such a case, you can use the "Restore" button to ask Defender to let you continue using the program. This program is now listed as an "Allowed" item, and Windows Defender will not flag the program in future scans.

SWITCH TO A FREE ANTIVIRUS PROGRAM



Crushes malware. Restores confidence.

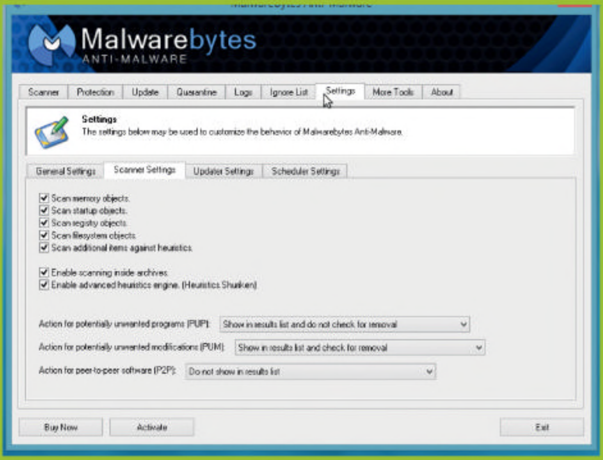
Because your antivirus alone is not enough.
Learn more about how it works »

Announcing Malwarebytes Secure Backup

45% Off for Schools—Limited Time Or

Got 45% Off Now »

1 DOWNLOAD AND INSTALL
Malwarebytes is available as a free download, so pay a visit to www.malwarebytes.org and get it from there. When installing the program on your PC, make sure you uncheck the box that enables the free trial of the Pro version.



Settings
The settings below may be used to customize the behavior of Malwarebytes Anti-Malware.

☑ Scan memory objects.
☑ Scan startup objects.
☑ Scan registry objects.
☑ Scan filesystem objects.
☑ Scan additional items against heuristics.

☑ Enable scanning inside archives.
☑ Enable advanced heuristics engine. (Heuristics Shuriken)

Action for potentially unwanted programs (PUP): Show in results list and do not check for removal
Action for potentially unwanted modifications (PUM): Show in results list and check for removal
Action for peer-to-peer software (P2P): Do not show in results list

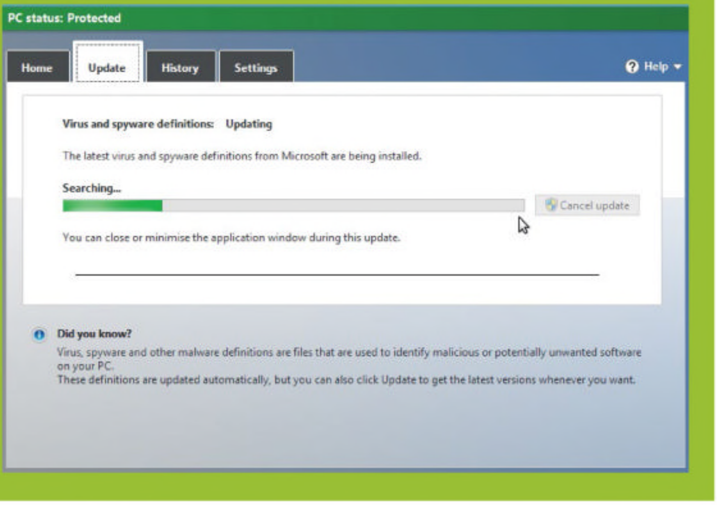
2 REVIEW SETTINGS
The free version of the program doesn't automatically download new malware definitions, so you'll need to update it each time you use it. Switch to the "Settings" tab to tweak the behavior of the program, though the defaults should work for most people.

TAKE ACTION

One important component of Windows 8.1 that plays a crucial role in keeping your computer safe and secure is the Windows Action Center. It monitors the most important aspects of the PC and divides them into two broad categories: security and maintenance. You can find the Action Center located within the desktop Control Panel, under "System and Security."

When something needs your attention, the Action Center flags up the problem. It color-codes any warnings that need your attention. Issues flagged with a yellow border could potentially affect the security or performance of the PC, while a red border is used for highlighting critical problems.

In addition to the color-coding, the Action Center also displays a description of the problem, along with a link to open the configuration window of the relevant tool to resolve the issue.



Virus and spyware definitions: Updating

The latest virus and spyware definitions from Microsoft are being installed.

Searching...

You can close or minimise the application window during this update.

Did you know?

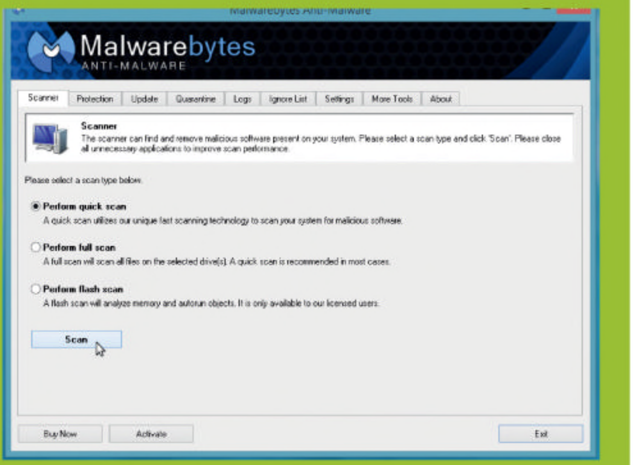
Virus, spyware and other malware definitions are files that are used to identify malicious or potentially unwanted software on your PC.
These definitions are updated automatically, but you can also click Update to get the latest versions whenever you want.

5 DEALING WITH MALWARE

Windows Defender does a good job of keeping your system clean, but if you're particularly paranoid about malware, you can use a dedicated anti-malware scanner, such as Malwarebytes (see "Switch To A Free Antivirus Program," below). However, there's a certain type of malware, known as a worm, which specializes in spreading over the network. Having a well-configured firewall is an essential safeguard against this type of malware. It also protects you against attackers trying to sneak into your computer and attempting to exploit the network capabilities of trusted programs.

6 WINDOWS FIREWALL

Windows Firewall is designed to block unwanted and potentially dangerous connections. Remember how Windows prompts you to choose whether a new network is a home, work, or public network? If you choose a public network, where your computer could be a sitting duck for a network attack, the Windows Firewall blocks almost all incoming connections in order to dissuade attackers.



Scanner

The scanner can find and remove malicious software present on your system. Please select a scan type and click 'Scan'. Please close all unnecessary applications to improve scan performance.

Please select a scan type below.

● Perform quick scan
A quick scan utilizes our unique fast scanning technology to scan your system for malicious software.

○ Perform full scan
A full scan will scan all files on the selected drive(s). A quick scan is recommended in most cases.

○ Perform flash scan
A flash scan will analyze memory and autorun objects. It is only available to our licensed users.

3 SCAN
From the "Scanner" tab, you can perform either a quick scan of your PC, or a full scan, which is more thorough and takes a fair bit of time to complete. The third type of scan offered, flash scan, is only available to licensed users.

7 TWEAKING THE FIREWALL

For the most part, there's no need to configure the Windows Firewall. Most programs that need to listen for incoming connections automatically tweak it to allow such connections during installation. However, Windows does allow users to manually configure the firewall. To bring up the Windows Firewall controls, type "firewall" on the Windows 8.1 Start screen. You'll notice several options in the main interface of the Windows Firewall.

» The "Allow an app or feature through Windows Firewall" option gives you a list of network-aware programs installed on your PC.

8 SHARING IS CARING

Along with these programs are details of whether they're allowed to communicate over private and public networks. Private networks allow sharing, while public networks are those over which sharing is restricted.

9 STAYING ALERT

To change the settings for a program, click "Change settings," then adjust your options. With "Change notification settings," you can tweak how the Windows Firewall alerts you—for example, when a new program is blocked—for both public and private networks. You also get options to either completely block incoming connections, which prevents you from even browsing the Internet, or to turn off the firewall altogether.

10 RESTORING DEFAULTS

If you wish to tweak Windows Firewall in greater detail, click on the "Advanced settings" option. Here you can control network traffic by creating firewall rules. For example, you can restrict traffic to specific ports and from specific IP addresses.

» Although incorrect modifications to the Windows Firewall can isolate your computer from the network, don't be afraid to experiment. You can always select "Restore defaults" and revert to the original settings.

Make Your Desktop A Thing Of Beauty

YOU'LL NEED THIS

RAINMETER
Download the desktop customization tool for free from rainmeter.net.

THE WINDOWS INTERFACE might be nice enough, but we all have different ways of working. Rainmeter is a powerful yet easy-to-use system that enables you to customize your Windows desktop with widgets that display to-do lists, calendars, weather, system statuses, and other useful information. If you want something quick and easy, then you can simply install and customize a ready-made suite. If you want more, you can hunt around for the perfect skin combination to create your own unique setup.

There are two main reasons to use Rainmeter—beauty and function. A community has grown up around the software and many people have created stylish suites that are available to download and use for free. Once you've transformed the aesthetic of your desktop, you can add the functionality that fits your way of using your computer. **–TANYA COMBRINCK**

1 DOWNLOAD RAINMETER

Point your browser at rainmeter.net, click the download link under "Final Release," and run the installer. You can then choose the standard installation. It's best to leave the default options in place unless you have a very old PC, in which case you should choose "32-bit."

2 LEARN YOUR WAY AROUND

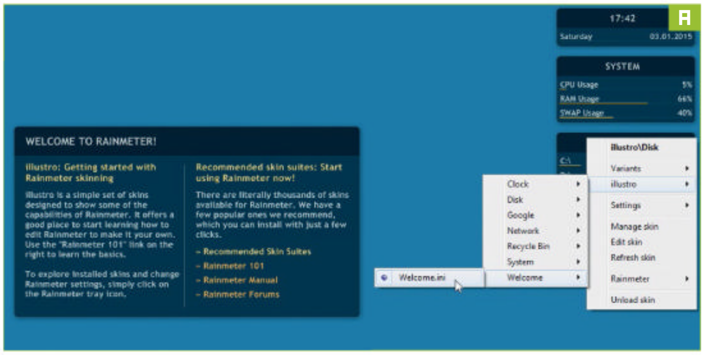
The first things you'll see are a few simple skins on your desktop from the "illustro" suite. There's a clock, some system monitors, and a welcome skin. To get rid of the welcome skin, simply right-click on any skin and choose "illustro → Welcome → Welcome.ini" [**Image A**]. You can just repeat this process if you want to bring it back.

3 DISPLAYING SKINS

You'll notice the illustro menu item contains options for several other skins: a Google search box, a Recycle Bin, and more system monitors. You can make them visible using the process in the previous step. They appear on top of one another in the top-left corner and can be dragged to new positions.

4 INSTALLING NEW SKINS

We're now going to install one of the most popular skin suites, Kaelri's Enigma. Go to http://bit.ly/1iXJGMZ, download Enigma, and run the installer. Now right-click any skin and choose "Rainmeter → Layouts → Enigma Preview" to see the new skins [**Image B**]. If you have trouble, choose "Rainmeter → Manage → Refresh all" and retry.


A
17:42
Saturday
03.01.2015
SYSTEM
CPU Usage 5%
RAM Usage 66%
SWAP Usage 40%
C:\
illustro\Disk
Variants
illustro
Settings
Manage skin
Edit skin
Refresh skin
Rainmeter
Unload skin
Clock
Disk
Google
Network
Recycle Bin
System
Welcome
Welcome.ini

WELCOME TO RAINMETER!

Illustro: Getting started with Rainmeter skinning

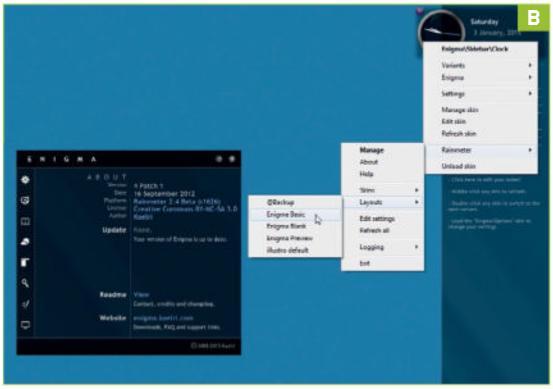
Illustro is a simple set of skins designed to show some of the capabilities of Rainmeter. It offers a good place to start learning how to edit Rainmeter to make it your own. Use the "Rainmeter 101" link on the right to learn the basics.

To explore installed skins and change Rainmeter settings, simply click on the Rainmeter tray icon.

Recommended skin suites: Start using Rainmeter now!

There are literally thousands of skins available for Rainmeter. We have a few popular ones we recommend, which you can install with just a few clicks.

- Recommended Skin Suites
- Rainmeter 101
- Rainmeter Manual
- Rainmeter Forums


B
Saturday
3 January, 2015
Enigma\Sidebar\Clock
Variants
Enigma
Settings
Manage skin
Edit skin
Refresh skin
Rainmeter
Unload skin
Manage
About
Help
Skins
Layouts
Edit settings
Refresh all
Logging
Exit
@Backup
Enigma Basic
Enigma Blank
Enigma Preview
illustro default
ENIGMA
ABOUT
4 Patch 1
16 September 2012
Update
Readme
View
Website

5 DELVING INTO ENIGMA

You can now work through the icons on the left of the "Options" dialog to customize any details you want to tweak. Deselect the "Options" dialog in the Enigma menu when you're finished, along with any skins you don't want to use. Right-click any skin and choose "Edit skin" if you want to adjust its behavior.

6 BEYOND ENIGMA

Now we're going to grab some other skins. Head to http://bit.ly/17tj0iX and install "Arcs," which is a graphical system monitor and clock. It should display automatically. Right-click and choose "Arcs → Legend" to see a diagram explaining what it all means. You can also opt for "Darks Arcs" if you prefer that color scheme.

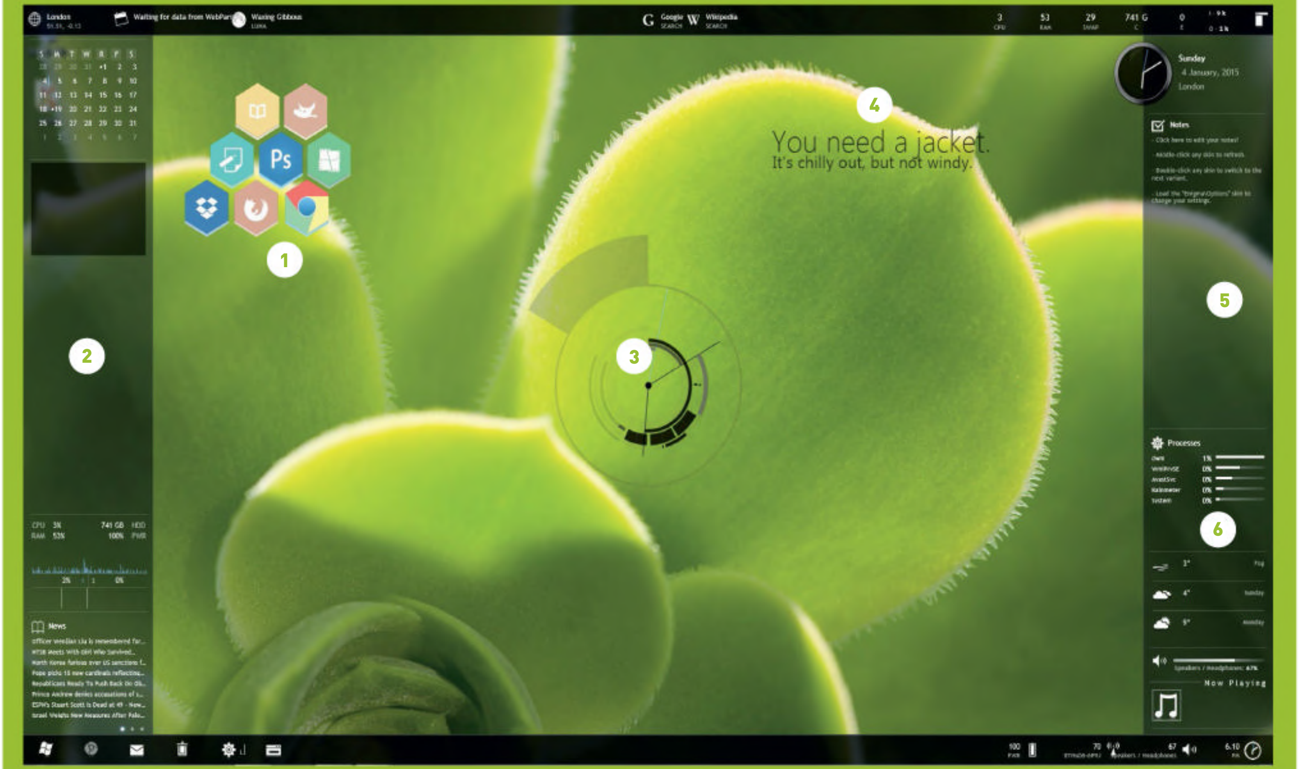
7 WINDOWS TWEAKS

We reckon the Windows Taskbar is cramping our style a bit, so right-click it and select "Properties → Auto-hide the taskbar." You may have to restart Windows before the Enigma Taskbar moves down. Also head to Control Panel and select a more interesting background to go with your sleek new desktop.

8 SKIN HUNTING

One of the best places to find more skins is rainmeterhub.com [**Image C**], as well as on rainmeter.net/discover. Do your research when installing

SHOWING SOME SKIN



You need a jacket.
It's chilly out, but not windy.

1. HONEYCOMB
The Honeycomb skin provides icons for a library of applications that can be arranged into a honeycomb. Go to rainmeterhub.com/skins/honeycomb.

2. THE ENIGMA SUITE
Everything you see around the edge of this desktop is from the Enigma suite, which is a collection of skins designed to work together.

3. ARCS
This stylish collection of arcs and circles houses a clock and system monitor that matches the Enigma suite.

4. YOU NEED A JACKET
For when looking out the window is simply far too much hassle. Get friendly clothing recommendations from your desktop with this skin that offers advice based on information from Yahoo weather.

5. EDITING SKINS
Right-click a skin and choose "Manage Skin" to bring up an options dialog. From here you can edit settings and "Unload" items you don't want.

6. PROCESSES
This handy and discreet skin displays currently active processes, so you can see at a glance what's eating up your PC's system resources.

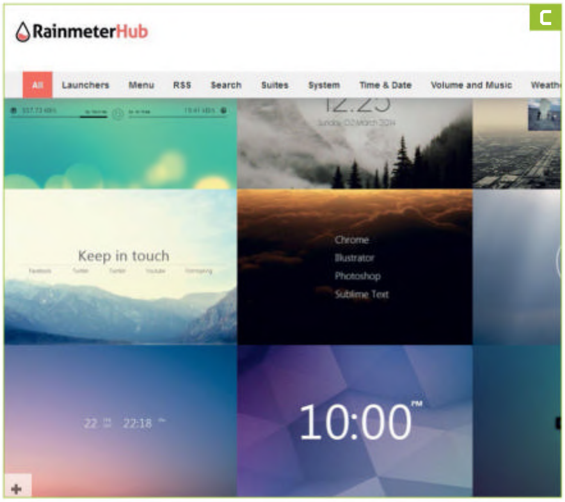
skins, as sometimes people hide malicious programs inside them. It's also a good idea to install an ad blocker, otherwise you'll see a lot of confusing download links.

9 MIX AND MATCH

Next we're going to add a weather skin that recommends what you should wear before venturing outside. Get it from rainmeterhub.com/skins/need-jacket/. Hover over the skin and click the cog to open its settings file, where you can change the font and the thresholds for its jacket advice. The question mark icon gives you instructions for entering your location.

10 SAVING LAYOUTS

Once everything's as you want it, you should save your setup as a layout. Right-click a skin and choose "Rainmeter → Manage" and go to the "Layouts" tab. Enter a name and click "Save," checking the wallpaper box if you like. Now your layout will appear in the "Rainmeter → Layouts" menu so you can always go back to it. ⏻



Overclock Your GPU

YOU'LL NEED THIS

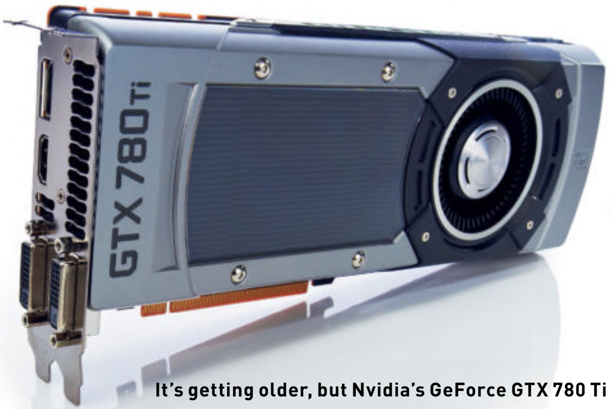
DEDICATED GPU
OCing integrated graphics isn't recommended. Use a dedicated GPU from AMD or Nvidia.

SOFTWARE
OCing software comes with GPUs, or can be downloaded.

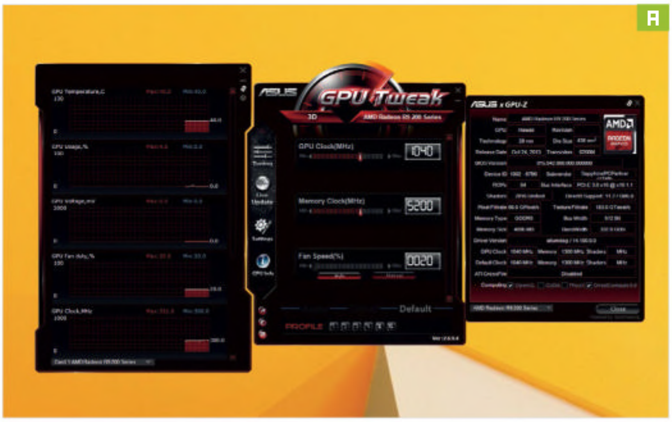
THERE COMES A TIME when however powerful your graphics card is, the latest games will stutter with all the visual settings cranked up to "Ultra." But that doesn't necessarily mean you need to buy a new GPU. By overclocking your graphics card you can make it work harder, without spending any cash. Of course, as with overclocking processors, there are caveats. We don't want to scare you off—for the most part, overclocking is safe and easy—but you should know the risks. You'll be pushing your card to its limits, and there's a slight chance things could go wrong. You should also check your GPU's warranty, because overclocking might invalidate it. Also keep your expectations in check. You should see improvements straight away, but if there's a game your graphics card is really struggling with, an overclock won't suddenly make it playable. If that's the case, you may still have to look at upgrading your GPU. –**MATT HENSON**

1 DO YOUR RESEARCH

A little reading at the start will save you time later, plus make sure your overclock is built on a sturdy foundation, so look up your graphics card. Type your card's model, make, and manufacturer into a search engine to see how other overclockers have fared (websites such as www.overclock.net have active forums). But only use their results as a rough guide. Don't assume you can just apply the same settings—your GPU might not be exactly the same, even if it seems so on paper. Applying a big leap in clock speeds is not advisable either, because putting in the wrong values could damage your hardware.



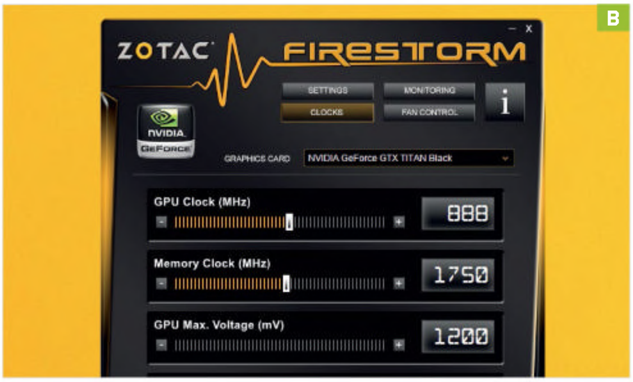
It's getting older, but Nvidia's GeForce GTX 780 Ti is still a strong card if you want a dedicated GPU.



GPU Clock(MHz) 1040

Memory Clock(MHz) 5200

Fan Speed(%) 0020



GRAPHICS CARD NVIDIA GeForce GTX TITAN Black

GPU Clock (MHz) 888

Memory Clock (MHz) 1750

GPU Max. Voltage (mV) 1200

2 GET TOOLED UP

Overclocking can be time-consuming, but there's a number of things that make the task easier than overclocking a processor. To begin with, the procedure is done using tools within Windows, rather than the BIOS, so you don't have to keep rebooting your machine. The various tools we're using to overclock the system are also more user-friendly.

» First, visit your card manufacturer's website (for Nvidia, see www.nvidia.com and click on "Drivers," for AMD, visit http://support.amd.com). Check your drivers are up to date.

» Next, visit http://unigine.com/products/heaven to download Heaven Benchmark. This is what you'll use to check your overclock is stable. Run Heaven and save the results before you start overclocking, so that a comparison can be made later.

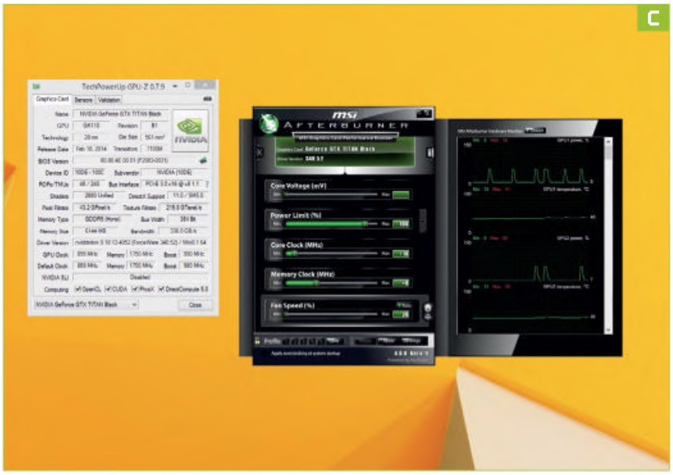
» Finally, download and install the overclocking and testing tools for seeing the benefits of the overclock and making sure it can perform under pressure. Here are three good options—the interfaces are largely similar, so it's mainly a personal choice.

» Asus GPU Tweak (**Image A**) comes with Asus GPUs or can be downloaded from http://bit.ly/PCFasustweak. When you run Tweak, you'll see a window with several sliders to apply to your overclock. On the right-hand side you'll see GPU-Z Incorporated, a handy tool for getting information about your card.

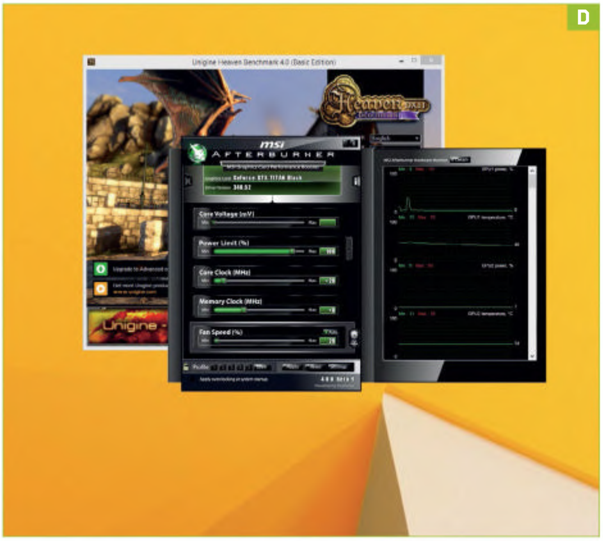
» Zotac Firestorm comes with Zotac GPUs or can be downloaded from www.zotac.com/z-zone/zotac-firestorm.html. It has a more understated design and you get a single window with a number of tabs. Clicking "Clocks" takes you to the overclocking section, which uses sliders to increase values (**Image B**). Click "Monitoring" for temperature, fan speeds, and more.

» Perhaps most popular is MSI Afterburner, which comes with MSI cards or at http://event.msi.com/vga/afterburner. This is the one we're using, but you can apply the same settings in the other overclocking tools if you have those instead.

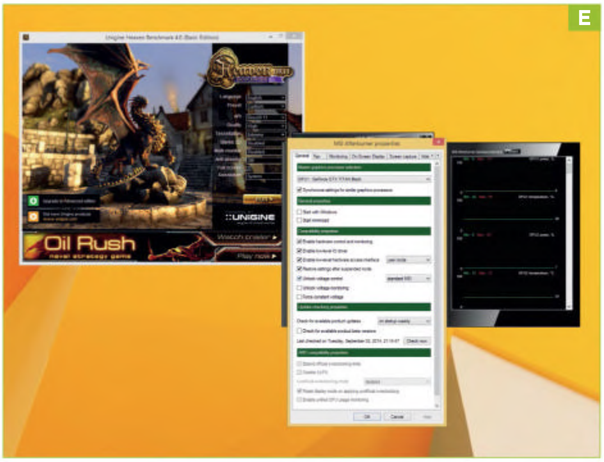
C



D



E



3 START THE OVERCLOCK

Begin by running Afterburner. On the first screen you'll see an overview of your card, and sliders that can be used to overclock it (**Image C**). On the right you'll see graphs that show the temperature and power levels of your card. Keep a close eye on these to make sure they remain safe.

» The best way to overclock is to increase by small increments, then test the stability. Go to the Core Clock (MHz) slider and up it by 10MHz. Once done, click "Apply." See if the overclock is successful by using GPU-Z (downloaded from www.techpowerup.com/gpuz) and checking the Clock entry.

» To ensure your overclock is stable, run the Heaven Benchmark (**Image D**). This puts your card through several intensive tests. At the main welcome screen, set Tessellation to "Extreme" and Antialiasing to "x8," then click "Run." Press [F9] to actually start the benchmark. If it completes without any problems, your overclock is stable and you can repeat the process.

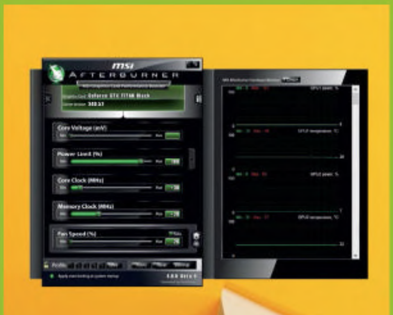
» Return to Afterburner and raise the core clock speed by another 10MHz, then check GPU-Z. If all's well, run Heaven Benchmark. If it's OK, repeat until you see an error, then return to the last stable value. A slightly riskier alternative, when your card falters, is to up the voltage. Simply click "Settings" in Afterburner and tick "Unlock voltage control" (**Image E**). Move the slider up 10mV and run the benchmark. If it's stable, increase again. Make sure the temperature hits no more than 90°C.

INCREASE THE MEMORY CLOCK

Once you've figured out how high you can push your GPU's core clock, you can do the same with the memory clock to eke out some more performance. The good news is that if you've gone through the process of overclocking the core clock, you know the drill.

Move the slider to increase the value by 10MHz and then click "Apply." Now, run Heaven Benchmark again and make sure no errors occur. Don't worry if the benchmark stutters—its aim is to really put your GPU through its paces, so it's doing its job. If the benchmark completes OK, return to Afterburner and increase the memory clock value by 10MHz again. Keep doing this until the overclock is unstable. When it is, dial the memory clock back to the last stable value. You'll now have your maximum overclock, and you can begin really stress testing your machine to make sure this overclock is stable.

If your PC behaves erratically, don't worry. Simply click the "Reset" button on Afterburner to return all the values to normal. The overclock is only applied when you run Afterburner, so you can start it up before playing games. If you want it to run automatically, place a tick next to "Apply overclocking at system startup."



Once your core clock is done, switch your attention to the memory clock.

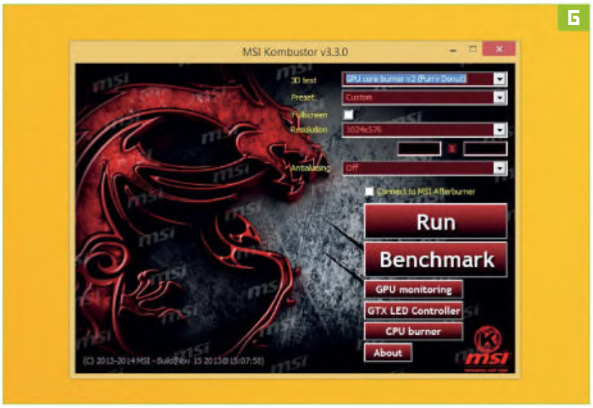
4 STRESS TESTS

It's vital you put your overclock through its paces, so fire up Heaven Benchmark again (**Image F**). This time, however, don't start the benchmark option. Just let it continue running—the longer you leave it, the more certain you can be that your system is stable. We recommend at least four hours. You don't need to sit glued to your monitor, but look out for artefacts and errors. If your PC is OK after that, you can be confident about your overclock.

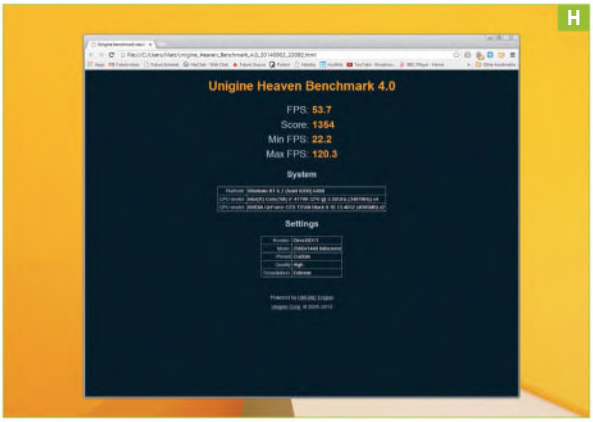
» While using Afterburner, you may have noticed a grayed-out "K" on the left. This links to MSI Kombuster (**Image G**), a tool for stress testing your overclocked GPU. To download and install the program, head to http://bit.ly/PCFkombustor; then the "K" icon in Afterburner will be highlighted. This program has a number of heavy-duty benchmarks, which really push your GPU and its overclock. If it survives these, it bodes well.

» Run Heaven again and save the results (they're saved as an HTML file). Open them up and compare them to the results you saved from the test you ran before you started overclocking (**Image H**). You can see the benefits the overclock has provided, including a higher score and higher fps. Another good benchmark is 3DMark (www.3dmark.com). Some games come with their own benchmark utilities as well.

» Now comes the fun part (**Image I**), as remember the point of overclocking your graphics card is to get improved performance in games. Load up your favorite games and have a play. Hopefully, you should notice frame rates are a lot smoother. You may even be able to increase the graphics settings. Download Fraps from www.fraps.com to see how your frame rates are performing.



3D test: GPU core burner v2 (Furry Donut)
Preset: Custom
Fullscreen: ☐
Resolution: 1024x576
Antialiasing: Off
☐ Connect to MSI Afterburner
(C) 2013-2014 MSI - Build Nov 15 2013@15:07:58



Unigine Heaven Benchmark 4.0
FPS: 53.7
Score: 1354
Min FPS: 22.2
Max FPS: 120.3
System
Settings

I
HOLD TO ENTER LYT2021

KEEP THINGS COOL

When overclocking your graphics card, it produces more heat than when running at stock speeds, so you must make sure it doesn't overheat. Keeping the mass of wires and cables under control works wonders for airflow, which is essential for keeping the components cool.

Many PC cases enable you to route your cables and wires behind the motherboard, giving your components room to breathe. Speaking of cases, yours should be a decent size, because small cases can get too hot when overclocking. Graphics cards usually come with their own fans and heatsinks. These are fine for stock speeds and even overclocking, but if you're going to be doing some heavy-duty overclocking, video editing, and gaming, you may want to buy some aftermarket coolers for your GPU.

Alternatively, you can incorporate a liquid cooling system to keep your processor and GPU cool.

Liquid cooling is fiddly and expensive, but looks great.

Secure Your Wireless Network

YOU'LL NEED THIS

ROUTER FIRMWARE
Download from manufacturer.

SECURING YOUR NETWORK BEYOND THE PASSWORD LEVEL seems like a chore. But with so many wireless devices just feet from your property, you need to go further to really protect your privacy. At the core of most home Wi-Fi networks is a router, which sends data between wireless devices and the Internet. To set up your router, you must access the admin panel through a web browser. This is where you enter your network address and account information. The admin panel is protected with a username and password, but that's just the first level of security. –**CHRISTIAN HALL**

1 PROTECTED SETUP AND UPDATED FIRMWARE

If updating your router, your new device will follow either the 802.11n or 802.11ac specification. It will almost certainly come with WPS (Wi-Fi Protected Setup), usually a button that lets you skip password setup until you've securely logged into the admin panel (**Image A**). Older routers can develop security issues as you attach new devices, so check the manufacturer's site for a firmware update.

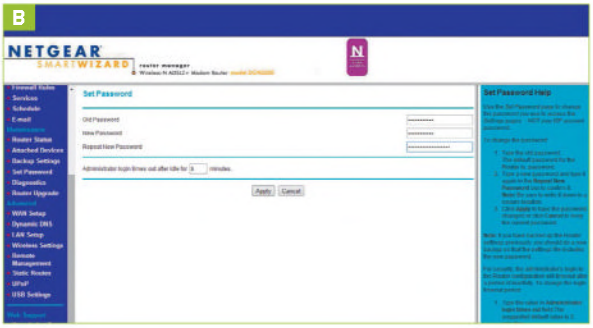
A

Power
Ethernet
Broadband
Internet
Wi-Fi
WPS

2 PASSWORDS AND SSID

You'll have to configure security options again after rebooting your router following a firmware update. We recommend using WPA-PSK or WPA2, and a new password that includes both letters and numbers (**Image B**). By default, routers broadcast their ID, but it's easy to stop. In your router's admin panel you'll find an option to stop broadcasting the SSID (service set identifier). To connect, you'll need to enter both the name and password; it won't appear on the list of available networks.

B



NETGEAR
SMARTWIZARD
router manager
Services
Schedule
E-mail
Router Status
Attached Devices
Backup Settings
Set Password
Diagnostics
Router Upgrade
WAN Setup
Dynamic DNS
LAN Setup
Wireless Settings
Remote Management
Static Routes
UPnP
USB Settings
Apply
Cancel
Set Password Help

Set Password

Old Password ••••••••••

New Password ••••••••••

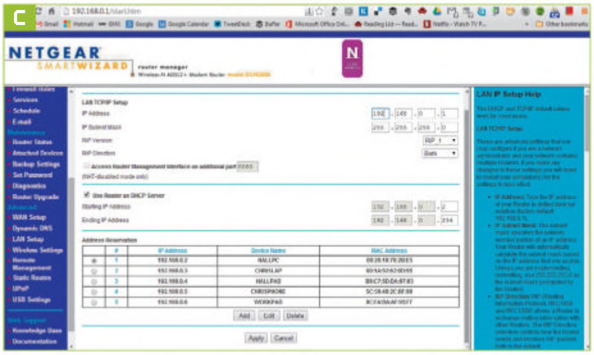
Repeat New Password ••••••••••••••

Administrator login times out after idle for 5 minutes.

3 MAC FILTERING

Your network will be faster, more reliable, and more secure if you give each device a static IP address, so you can easily see which devices are connecting. For a simple guide, see http://bit.ly/1pQNEa1. Create a list of MAC addresses for your devices (**Image C**), only allowing these to connect while blocking unrecognized devices. Look for an address filtering option in your router admin panel. To find the MAC address for a Windows PC, type "getmac" in the Command Prompt.

C



192.168.0.1/start.htm
NETGEAR
SMARTWIZARD
router manager
Services
Schedule
E-mail
Router Status
Attached Devices
Backup Settings
Set Password
Diagnostics
Router Upgrade
WAN Setup
Dynamic DNS
LAN Setup
Wireless Settings
Remote Management
Static Routes
UPnP
USB Settings
Knowledge Base
Documentation
Add
Edit
Delete
Apply
Cancel
LAN IP Setup Help

LAN TCP/IP Setup

IP Address 192 . 168 . 0 . 1

IP Subnet Mask 255 . 255 . 255 . 0

RIP Version RIP_1

RIP Direction Both

☐ Access Router Management Interface on additional port

☑ Use Router as DHCP Server

Starting IP Address 192 . 168 . 0 . 2

Ending IP Address 192 . 168 . 0 . 254

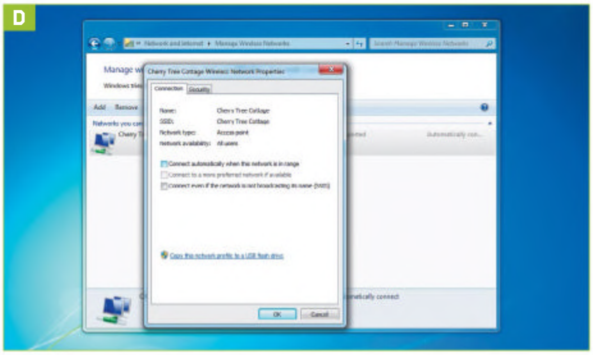
Address Reservation

	#	IP Address	Device Name	MAC Address
●	1	192.168.0.2	HALLPC	[illegible]
○	2	192.168.0.3	CHRISLAP	[illegible]
○	3	192.168.0.4	HALLPAD	[illegible]
○	4	192.168.0.5	CHRISPHONE	[illegible]
○	5	192.168.0.6	WORKPAD	[illegible]

4 DISABLE AUTOCONNECT AND WIRELESS ADMIN

Connecting to open Wi-Fi networks exposes your PC. Disable this by clicking "Control Panel → Network and Sharing Center → Manage Wireless Networks." Right-click the one you want to change, click "Properties → Connection" and uncheck "Connect automatically" (**Image D**). Restrict router admin through a wireless connection to stop wireless hacking. ⏻

D



Network and Internet
Manage Wireless Networks
Add
Remove
Connection
Security
OK
Cancel

Cherry Tree Cottage Wireless Network Properties

Name: Cherry Tree Cottage

SSID: Cherry Tree Cottage

Network type: Access point

Network availability: All users

☐ Connect automatically when this network is in range

☐ Connect to a more preferred network if available

☐ Connect even if the network is not broadcasting its name (SSID)

Getting Past The POST

YOU'LL NEED THIS

MOTHERBOARD MANUAL

POZIDRIV SCREWDRIVER
For any disassembly.

DANG, IT'S DEAD. You've pressed the power button and your PC's got little sign of life, let alone an operating system. You may have some text from the BIOS flash past, or a blue screen, or a blank screen. You may have complete silence or a flurry of beeping noises and frantic fans. Never mind driver problems, this is more fundamental than that. Your box has fallen at the first fence. The Power-On Self Test (POST) has bombed. Here's the *Maximum PC* guide to digging yourself out of the hole and getting your PC properly powered up.

–CHRIS LLOYD

1 ARE YOU ALL PLUGGED IN?

Keep it simple and start with the basics. Never underestimate how easy it is to make a fundamental error.

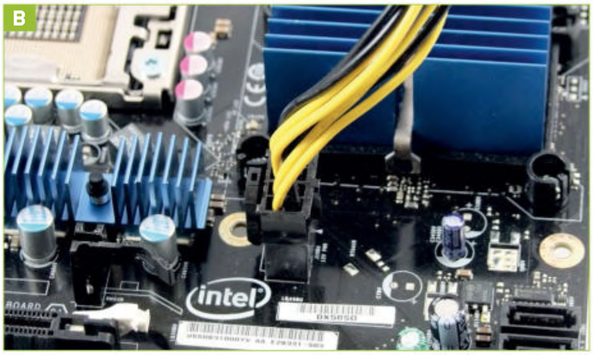
» Is it really on? On the back of your PSU there is probably an innocuous-looking black rocker switch (**Image A**). This turns it on. Often never touched in everyday use, it's possible to forget about it and start messing with the panel switches and worrying about dead components when all the time you haven't switched on the juice, especially on an unfamiliar PSU. If this still fails, try replacing the power cable—you may have a faulty one—even if that's fairly unlikely.

» Next check the processor power (**Image B**). Chips get their own power supply, and it's ridiculously easy to forget to plug this bit in, which leads to a seemingly dead system. It'll use either an 8-pin block or a 4-pin block. Often the power supply lead splits the 8-pin into two 4-pins to be compatible with both. It's the socket right next to your processor, often labelled "12v ATX." If in doubt then it's in the manual (which you've read, haven't you?). Another easy miss is the power for your CPU cooler. Some boards refuse to do anything unless they detect this plugged in.

» Now for video power. Nothing on the monitor? Another easily overlooked connection is the graphics card's power supply. They can be hungry things, and only the gutless kind can run off the socket power alone, a mere 75W maximum. The exact requirements depend on the beefiness of the card. There are either one or two 6-pin blocks and/or an 8-pin block. Just make sure they're all filled. It's best to use cables directly from the PSU rather than adapters. Check you've no loose wires in the blocks, and don't force it, they only go in one way (**Image C**).

» Finally, give the front panel switches a once over. They're fiddly little cables that are easily missed. The polarity of the reset and power switches isn't important. If your activity lights fail to light, try reversing the connection. Disconnect the reset switch if you suspect a short (either not booting, or endless booting). You can also fire a system manually by shorting the power pins with a small metallic object if you suspect your case switch, but make sure you've properly identified them.

A
100-240VAC



2 OK, SO IT'S ALL PLUGGED IN. WHAT'S NEXT?

A poorly seated video card is a common error. The cards can take considerable force to get them properly seated, more than a novice builder may be expecting (**Image D**). This can be worrying, as flexing your board is really not a good idea. Make sure the board is fully supported with stand-off posts before applying pressure. Many boards have securing clips for the card—if you can't get these to click into place neatly, then the card needs pushing down further. Try removing and re-seating if the angle is at all crooked. Be firm and gentle at the same time (yes, we know this is impossible, but you know what we mean).

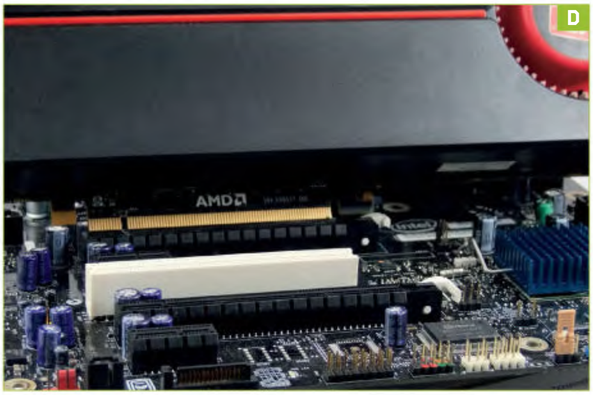
» Another potential issue could be unwanted shorts. If an electrical conductor touches your board then it can cause a short circuit on the fine network of tracks, which is guaranteed to cause trouble. Check the small posts that the board sits on. Did you install them all in the correct places? There is no standard pattern, meaning it's easy to get one of them in the wrong place, especially as you won't see it from the top either. A misplaced one can easily cause a short circuit on exposed soldering (**Image E**).

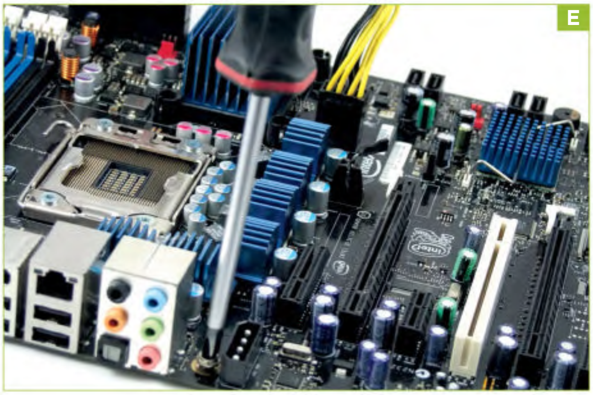
» Did you drop a screw in there? It's easily done (**Image F**). Retrieve everything you drop straight away in case you forget. Are there any wires touching the board which may have worn insulation? It's good practice to have all wires routed well away from the board, especially underneath, which has sharp soldered connections that can cut into wires. Many cases have a tray under the board to keep wires out of such trouble.

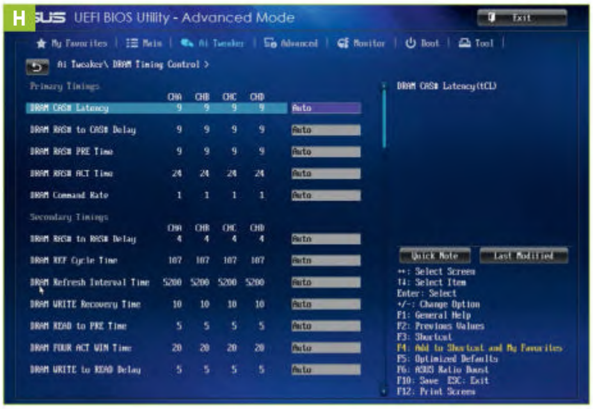
» It's worth checking your memory modules are all fully seated, with the securing clips in place (**Image G**). This can take more force than you might expect. Are they in the right slots? Some boards want the slots used in a strict order, others aren't fussy. Check the manual to make sure you've filled them in the right order as wrongly configured RAM is a common cause of dead boxes. It must match the board and processor. Try booting with a single stick of RAM, or one pair for coupled systems. You may have either a faulty RAM socket, or stick, so mix it about to pin it down.

» Potentially, the issue is with the memory speed. If it can boot with at least one stick of RAM, then enable the XMP (Extreme Memory Profile, basically factory-approved overclocking) in the BIOS if the board supports it, or manually set memory speeds in the BIOS to match your stick's specs. If you have sticks rated at a higher voltage than the default settings allow, it can cause stability problems. On some boards, leaving it on "Auto" won't supply enough juice (**Image H**) .

» Now check your processor is seated cleanly, flat, and the right way around (**Image I**). These days it's hard to get the processor in the wrong way around—it's physically impossible for most. There's a visual indicator on the chip (a little arrow or similar). The socket will have the same indicator, or will be obviously not symmetrical. This is one bit of hardware where undue force should never be used as we don't want a bent pin or a borked socket. Pins can be coaxed back to vertical, very, very carefully. But if it breaks, you're stuffed.







Ai Tweaker\ DRAM Timing Control >

Primary Timings

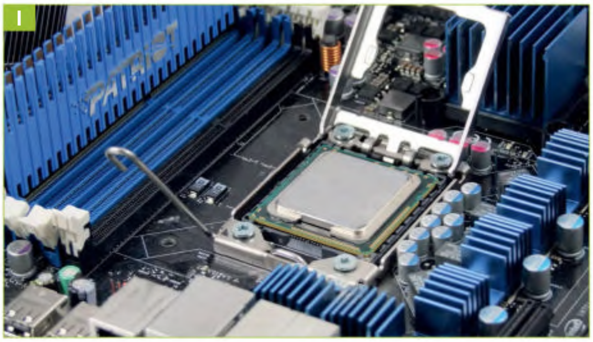
	CHA	CHB	CHC	CHD	
DRAM CAS# Latency	9	9	9	9	Auto
DRAM RAS# to CAS# Delay	9	9	9	9	Auto
DRAM RAS# PRE Time	9	9	9	9	Auto
DRAM RAS# ACT Time	24	24	24	24	Auto
DRAM Command Rate	1	1	1	1	Auto

Secondary Timings

	CHA	CHB	CHC	CHD	
DRAM RAS# to RAS# Delay	4	4	4	4	Auto
DRAM REF Cycle Time	107	107	107	107	Auto
DRAM Refresh Interval Time	5200	5200	5200	5200	Auto
DRAM WRITE Recovery Time	10	10	10	10	Auto
DRAM READ to PRE Time	5	5	5	5	Auto
DRAM FOUR ACT WIN Time	20	20	20	20	Auto
DRAM WRITE to READ Delay	5	5	5	5	Auto

DRAM CAS# Latency(tCL)

↔: Select Screen
↑↓: Select Item
Enter: Select
+/-: Change Option
F1: General Help
F2: Previous Values
F3: Shortcut
F4: Add to Shortcut and My Favorites
F5: Optimized Defaults
F6: ASUS Ratio Boost
F10: Save ESC: Exit
F12: Print Screen



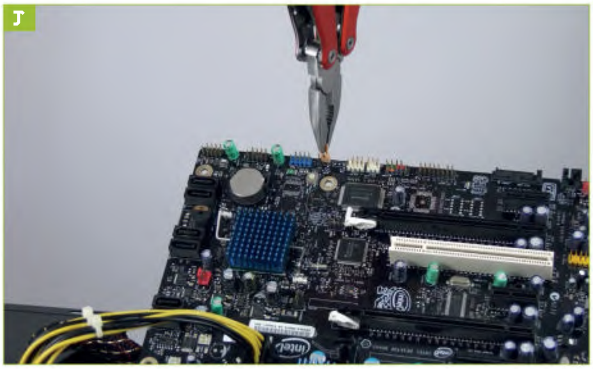
3 YOU'VE COVERED THE OBVIOUS BASES, NOW WHAT?

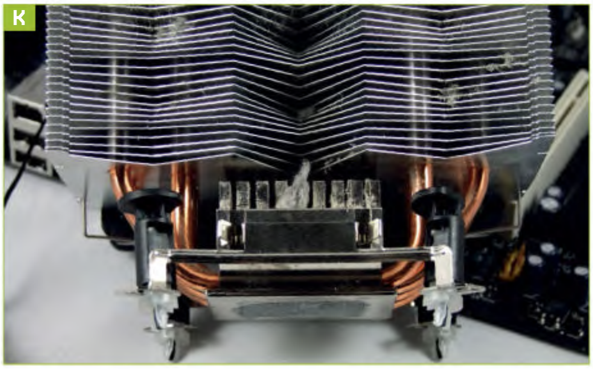
Your processor cooler can look OK to the eye, but it needs to be firmly in place and completely flush, otherwise the processor will overheat in very short order. Are all of the connectors snug and the cooler level? Did you put a (tiny) bit of thermal paste on? The surface between the top of the chip and your cooler needs to be good and true—sorry, but there's no "that looks good enough" here. The motherboard's thermal cut-out will trigger if it detects the temperature going through the roof. This may only take seconds.

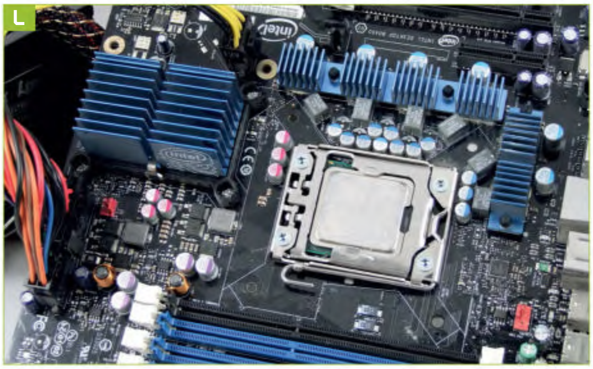
» Clearing the BIOS is not to be considered too early as it will wipe useful information. But resetting the CMOS can fix some settings woes. The simple way is to go into the BIOS and restore the factory settings. The exact wording varies, "Clear BIOS," "Reset to Default," or similar. Not a lot of help on a system that's dead before you can get into the BIOS setup. Most boards have a jumper or DIP switch that will reset the CMOS (see that manual). Once cleared, your BIOS will re-detect all your hardware on booting, which may clear an overlooked incompatibility (**Image J**).

» Does everything appear to fire but the chip fan goes mental and then the whole system locks up? It could be processor cooling. Assuming your cooler is fitted properly, next suspect a restricted airflow, hence the fan running on maximum. Often it's an accumulation of dust deep inside the cooler, sitting between the fan and lodged in the cooling fins (**Image K**). Or you may have hair wrapped around the fan itself, causing it to struggle. A fine pair of tweezers or a more thorough disassembly will put things right. If your rig sits on the floor and gets heavy use, this could be a reoccurring and common woe.

» If you've a board with layers of dust and grime, you may have collected dielectric material, or the scum may be acting as a blanket of insulation (**Image L**). Blowing is best, using your mouth, an air duster, or hairdryer (not too hot). Use a soft brush on more stubborn bits. If it's really grubby, you have the death or glory option of washing it in water (yes, really). Remove any CMOS battery and dip into the wet stuff (some espouse special solvents, but clean water leaves very little residue). Be very gentle and leave to dry, days not hours (a gentle blow-dry will help). Obviously it must be totally dry before running any power. If it works, glory. If not, tough—it's totally dead now.


J


K


L

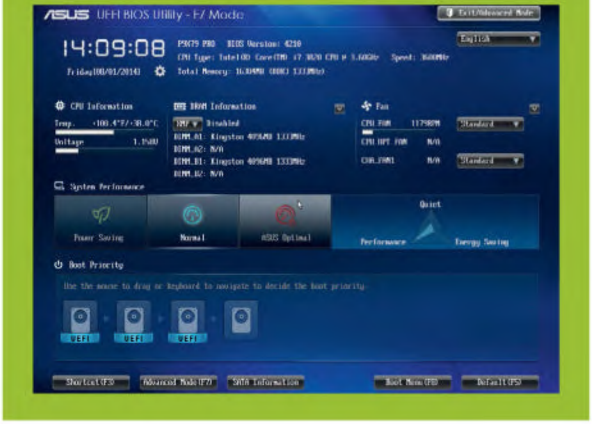
BEEPING BEEPS

If your box is beeping, it's trying to tell you something. To hear these tones you used to need a system speaker. Unlike your regular sound system, a system speaker is separate and specifically for error codes, but we haven't seen one of those for years, as boards now have their own beep-maker.

IBM set out the original set of beep codes. One long beep and two short, for example, means it can't find a working graphics card. BIOS makers have since added more error codes, but there's no standard for what each one means. There are some consistencies (small numbers of short beeps are mostly memory errors), but there are also enough inconsistencies for it to annoyingly require specific documentation.

If your system beeps, however, it means we have a clue, and to the manual we go, or a working Internet connection (search for "POST error codes"—the top articles are all fairly good, especially the TechNick one). Once you've located the source, remove and re-seat the offending hardware and try again. If it's a powered component, check the power is plugged in. Possibly try a different power cable. Try swapping things around as described in the main text if it's a memory error.

While the error codes are a decent pointer, they give no idea as to the exact problem—it may be a seating problem or it may be trashed. But they're a huge help.



DIMM_A1: Kingston 4096MB 1333MHz
DIMM_A2: N/A
DIMM_B1: Kingston 4096MB 1333MHz
DIMM_B2: N/A
CPU_FAN 1179RPM
CPU_OPT FAN N/A
CHA_FAN1 N/A

Fix Your Ultra-Widescreen Woes

YOU'LL NEED THIS

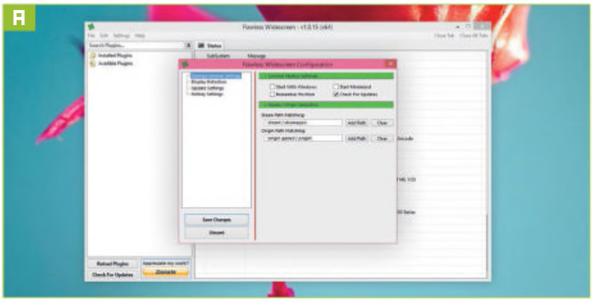
FLAWLESS WIDESCREEN
Pick up the program at www.flawlesswidescreen.org.

WHEN THE FIRST 29-inch ultra-widescreen monitors arrived, we loved their potential but decried their use on the standard Windows desktop due to the lack of vertical height. But LG and AOC have launched 34-inch monitors with 3440x1440 native resolutions, so we're back on board. They're still niche displays though, and many games don't support them out of the box. You either get black bars down the sides or stretched images. Luckily, a programmer created Flawless Widescreen—it's very easy to use, and can source game locations from both Steam and Origin. **–DAVE JAMES**

1 DRIVER TIME

Before you get started, ensure your graphics drivers are up to date. Go to your card manufacturer's website and download the current version. Now download the Flawless Widescreen app at www.flawlesswidescreen.org. Once it's installed, a shortcut will appear on your desktop. Launch it and you'll be asked if you want to change the settings (hint—you do). First check your game locations (**Image A**). Steam and Origin locales are in place by default. You can also add new ones.

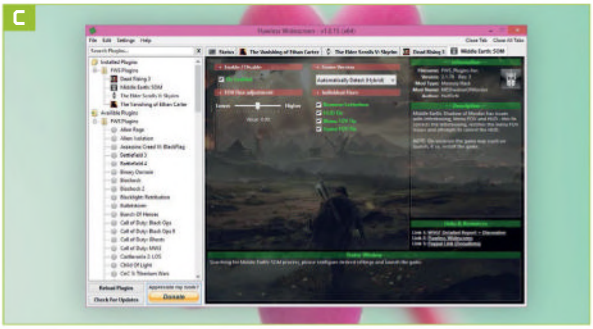
A



3 PLUG IT IN

In Update Settings you can arrange how to keep your game plugins up to date. The standard setting lets you choose which specific plugins to install, but it can install them automatically if you want. On the left-hand side of the display you'll see the available game plugins (**Image C**). The specific titles known to have widescreen problems are likely to be available, and new ones are added regularly. Simply double-click on the plugin for your chosen game to install it.

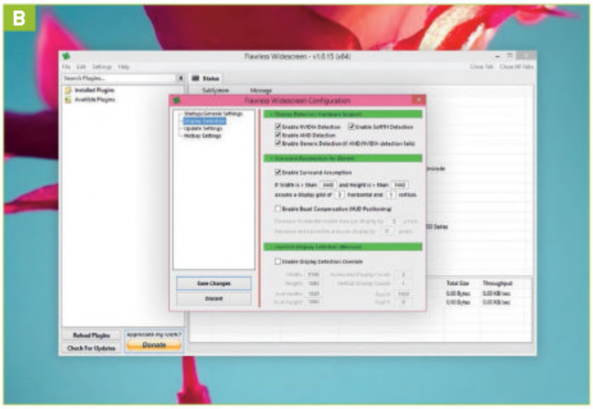
C



2 ARE YOU SURROUNDED?

The next step is to sort out the software's Display Detection. By default it's set up to target surround visuals with grouped monitors, but if you rock a single 21:9 screen, that can lead to distortion at the edges. Under the Surround Assumption section (**Image B**), enter the resolution of your current screen to prevent the program treating your screen as though it's a wrap-around display array.

B



4 MR FIX IT

Once you've got your plugin installed, make sure the "Fix enabled" checkbox is ticked. The fix is in, so now is the time to start up the game and check to see if the plugin is working for your display (**Image D**). Flawless Widescreen offers little tweaks if you're not satisfied with how things have worked out post-fix. Experiment with the FOV slider and individual fixes to adjust how your game looks.

D

Customize Windows 8.1

YOU'LL NEED THIS

CLASSIC SHELL
Head to www.classicshell.net for a new custom Start menu.

STARTISBACK+
Does what you'd expect. Get it from http://bit.ly/1eDnJ2h. To run it, you'll need Chocolatey. Find it at http://bit.ly/qbvEmi.

POKKI
Also restores the Start menu (http://bit.ly/1f9GKIO).

THE WINDOWS 8.1 INTERFACE is the latest iteration of the Windows desktop, but you don't have to stick with the default look. The Modern UI was a radical change, and many people still expect the Windows Start button to bring up a classic Start menu rather than the new Start Screen (and get frustrated when it doesn't). But with a few tweaks, that core interface element can be returned. We'll look at three different versions you can install for free.

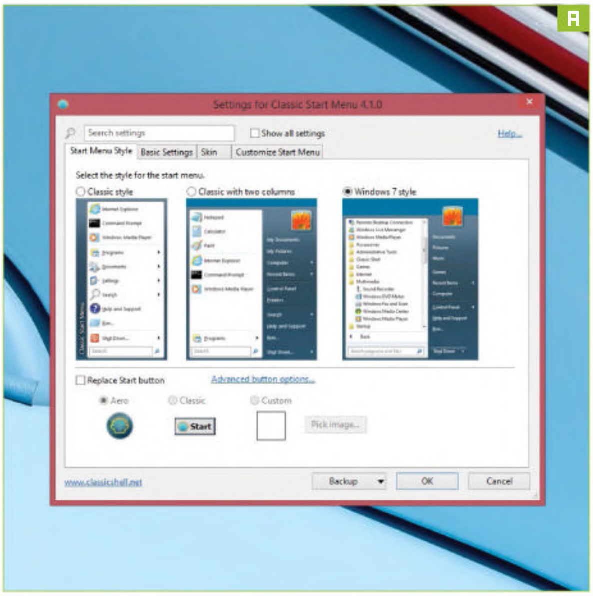
Plus, there are more ways to improve the OS. For example, the slimmed-down desktop means it isn't always obvious where to go for the options to change the interface, but main ones can be found by right-clicking the Taskbar and clicking Properties. Another thing that might annoy you is Microsoft's decision to disable the Libraries feature by default, but this can be reinstated by opening "Windows Explorer → View → Options" and ticking "Show libraries." Read on for more handy tips. –**CHRISTIAN HALL**

1 GET THE START MENU BACK AND CUSTOMIZE IT

Various third-party programs will bring back the classic Windows Start menu in Windows 8. One of the most popular is Classic Shell (free at www.classicshell.net). This gives you three different styles for the Start menu (**Image A**), options for the Start button, and skin choices to make it fit naturally into Win8 (such as reducing transparency and changing icon size).

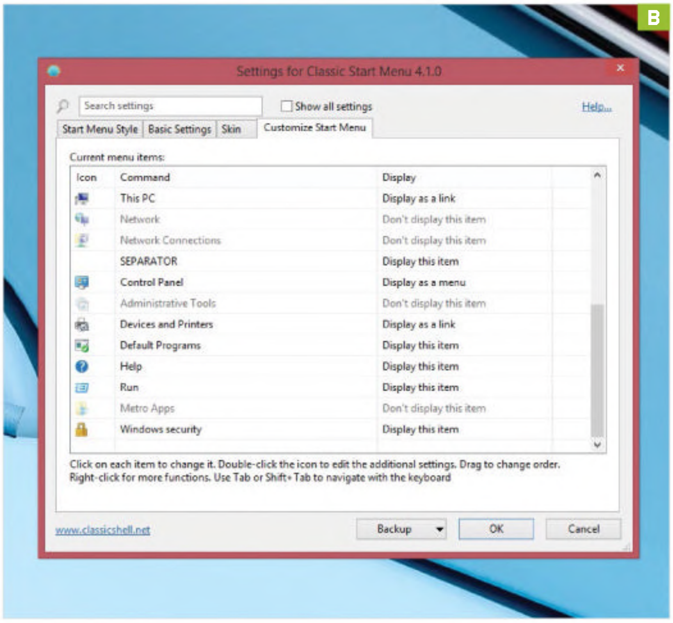
» You can right-click on the Start button and select "Settings" to bring up the Classic Shell options at any point (**Image B**). You've already chosen a style for your new Start menu, so click "Customize Start Menu" to choose which menu items you want included. Beside each program in the list, choose either "Don't display," "Display as a link," or "Display as a menu" to suit the way you work.

» Another option is StartIsBack+ (**Image C**). Before you can begin, install the PowerShell execution engine, Chocolatey, from http://bit.ly/qbvEmi. Once that's done, download the StartIsBack+ installer package from http://bit.ly/1eDnJ2h. You can't execute this file—instead, you must go into the Command Prompt and type "cinst startisbackplus," then hit Enter.


A
Settings for Classic Start Menu 4.1.0
Search settings
☐ Show all settings
Help...
Start Menu Style
Basic Settings
Skin
Customize Start Menu
Replace Start button
Advanced button options...
Start
Pick image...
www.classicshell.net
Backup
OK
Cancel

Select the style for the start menu.
○ Classic style ○ Classic with two columns ● Windows 7 style

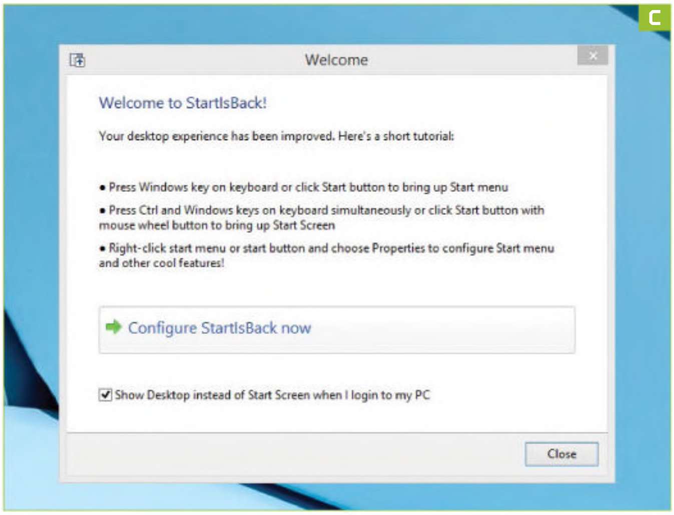
☐ Replace Start button
● Aero ○ Classic ○ Custom


B
Settings for Classic Start Menu 4.1.0
Search settings
☐ Show all settings
Help...
Start Menu Style
Basic Settings
Skin
Customize Start Menu
www.classicshell.net
Backup
OK
Cancel

Current menu items:

Icon	Command	Display
	This PC	Display as a link
	Network	Don't display this item
	Network Connections	Don't display this item
	SEPARATOR	Display this item
	Control Panel	Display as a menu
	Administrative Tools	Don't display this item
	Devices and Printers	Display as a link
	Default Programs	Display this item
	Help	Display this item
	Run	Display this item
	Metro Apps	Don't display this item
	Windows security	Display this item

Click on each item to change it. Double-click the icon to edit the additional settings. Drag to change order. Right-click for more functions. Use Tab or Shift+Tab to navigate with the keyboard

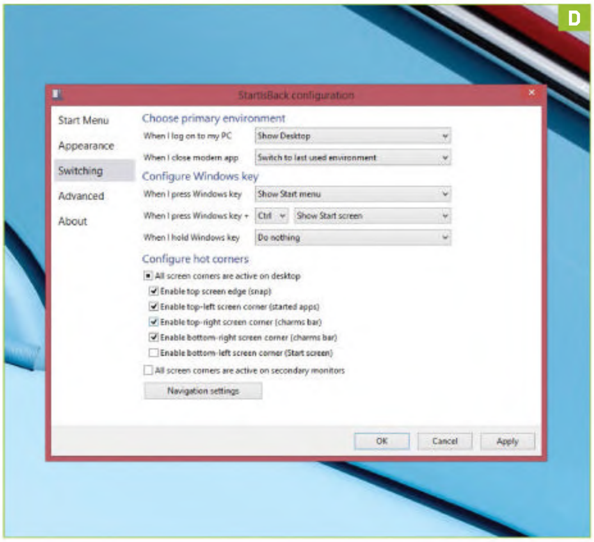

C
Welcome
Configure StartIsBack now
Close

Welcome to StartIsBack!

Your desktop experience has been improved. Here's a short tutorial:

- Press Windows key on keyboard or click Start button to bring up Start menu
- Press Ctrl and Windows keys on keyboard simultaneously or click Start button with mouse wheel button to bring up Start Screen
- Right-click start menu or start button and choose Properties to configure Start menu and other cool features!

☑ Show Desktop instead of Start Screen when I login to my PC


D

StartIsBack configuration
Start Menu
Appearance
Switching
Advanced
About

Choose primary environment

When I log on to my PC: Show Desktop

When I close modern app: Switch to last used environment

Configure Windows key

When I press Windows key: Show Start menu

When I press Windows key + Ctrl: Show Start screen

When I hold Windows key: Do nothing

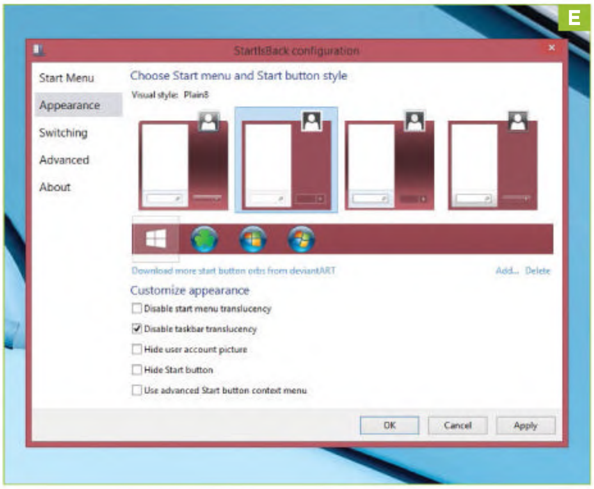
Configure hot corners

- ■ All screen corners are active on desktop
  - ☑ Enable top screen edge (snap)
  - ☑ Enable top-left screen corner (started apps)
  - ☑ Enable top-right screen corner (charms bar)
  - ☑ Enable bottom-right screen corner (charms bar)
  - ☐ Enable bottom-left screen corner (Start screen)
- ☐ All screen corners are active on secondary monitors

Navigation settings
OK
Cancel
Apply

2 SWITCHING OPTIONS

Now restart Windows. Under the "Switching" tab you can specify what your PC should do when you boot into Windows 8 (**Image D**), and configure the Windows key to perform a certain action in the interface. You can also configure hot corners from this menu—a feature missing from Windows 8.1 as standard. All of this means you can change the default interface settings to better suit your needs.


E

StartIsBack configuration
Start Menu
Appearance
Switching
Advanced
About

Choose Start menu and Start button style

Visual style: Plain8

Download more start button orbs from deviantART
Add...
Delete

Customize appearance

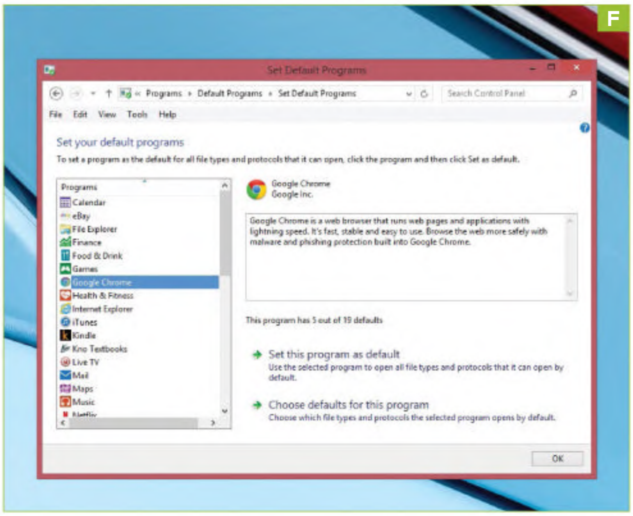
- ☐ Disable start menu translucency
- ☑ Disable taskbar translucency
- ☐ Hide user account picture
- ☐ Hide Start button
- ☐ Use advanced Start button context menu

OK
Cancel
Apply

3 CHANGE THE START BUTTON

You can also make some visual alterations with StartIsBack+ under the "Appearance" tab (**Image E**). For instance, you can get the old Windows 7 Start orb back, instead of the new white Windows logo. There's also a link here to DeviantART, where you'll find custom Start buttons that you can download and install. You can select new visual styles for the whole Start menu, too.

» Windows 8 Start Menu by Pokki (download it free from www.pokki.com/windows-8-start-menu) is another great tool, but it doesn't actually replace the Start button. With Pokki, you can search and organize your favorite apps and websites on your desktop, just like you would on a smartphone.


F

Set Default Programs
Programs › Default Programs › Set Default Programs
Search Control Panel
File
Edit
View
Tools
Help

Set your default programs

To set a program as the default for all file types and protocols that it can open, click the program and then click Set as default.

Programs
Calendar
eBay
File Explorer
Finance
Food & Drink
Games
Google Chrome
Health & Fitness
Internet Explorer
iTunes
Kindle
Kno Textbooks
Live TV
Mail
Maps
Music
Netflix

Google Chrome
Google Inc.

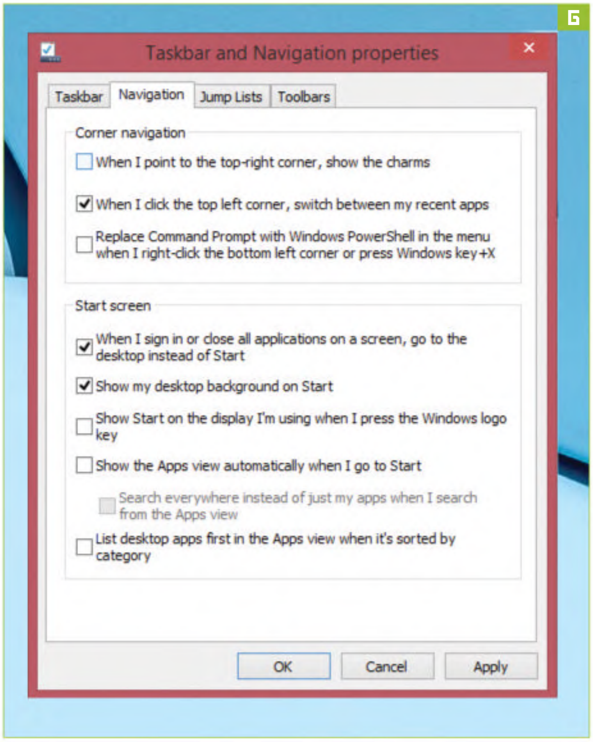
Google Chrome is a web browser that runs web pages and applications with lightning speed. It's fast, stable and easy to use. Browse the web more safely with malware and phishing protection built into Google Chrome.

This program has 5 out of 19 defaults

→ Set this program as default
Use the selected program to open all file types and protocols that it can open by default.

→ Choose defaults for this program
Choose which file types and protocols the selected program opens by default.

OK


G

Taskbar and Navigation properties
Taskbar
Navigation
Jump Lists
Toolbars

Corner navigation

- ☐ When I point to the top-right corner, show the charms
- ☑ When I click the top left corner, switch between my recent apps
- ☐ Replace Command Prompt with Windows PowerShell in the menu when I right-click the bottom left corner or press Windows key+X

Start screen

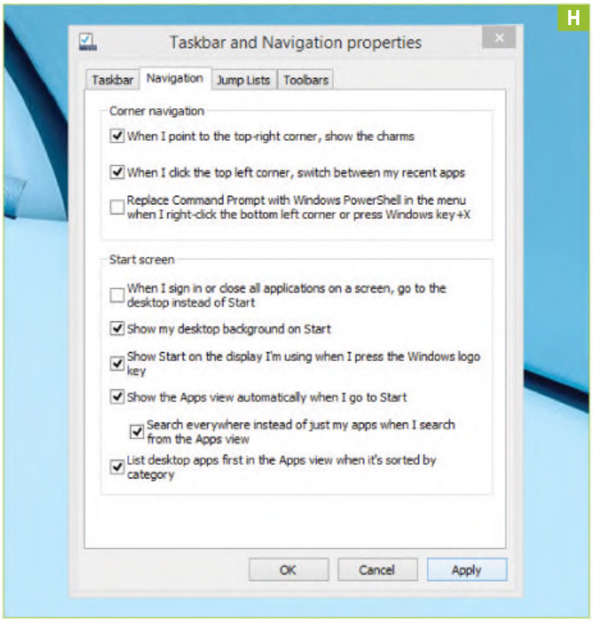
- ☑ When I sign in or close all applications on a screen, go to the desktop instead of Start
- ☑ Show my desktop background on Start
- ☐ Show Start on the display I'm using when I press the Windows logo key
- ☐ Show the Apps view automatically when I go to Start
  - ☐ Search everywhere instead of just my apps when I search from the Apps view
- ☐ List desktop apps first in the Apps view when it's sorted by category

OK
Cancel
Apply

4 ESCAPE THE MODERN INTERFACE

Music, videos, pictures, and PDFs are automatically opened using Modern UI apps by default, but you can change this behavior so they open within the desktop instead. From the Start screen, type default programs and click on the "Default programs" icon under the results. Click "Set your default programs" and choose the app you want to set as your default for each file type (**Image F**).

» While you're at it, disable the Charms as well. Charms in Windows 8.1 are designed to speed up access to menus, but they're activated by the hot corners, which can be a nuisance. If you find yourself inadvertently activating the menu with your mouse whenever you move the pointer to the top-right, it's possible to disable it. Go to "Taskbar → Properties → Navigation" and untick "When I point to the top-right corner, show the Charms" (**Image G**).


H
Taskbar and Navigation properties
Taskbar
Navigation
Jump Lists
Toolbars
OK
Cancel
Apply

Corner navigation

☑ When I point to the top-right corner, show the charms

☑ When I click the top left corner, switch between my recent apps

☐ Replace Command Prompt with Windows PowerShell in the menu when I right-click the bottom left corner or press Windows key+X

Start screen

☐ When I sign in or close all applications on a screen, go to the desktop instead of Start

☑ Show my desktop background on Start

☑ Show Start on the display I'm using when I press the Windows logo key

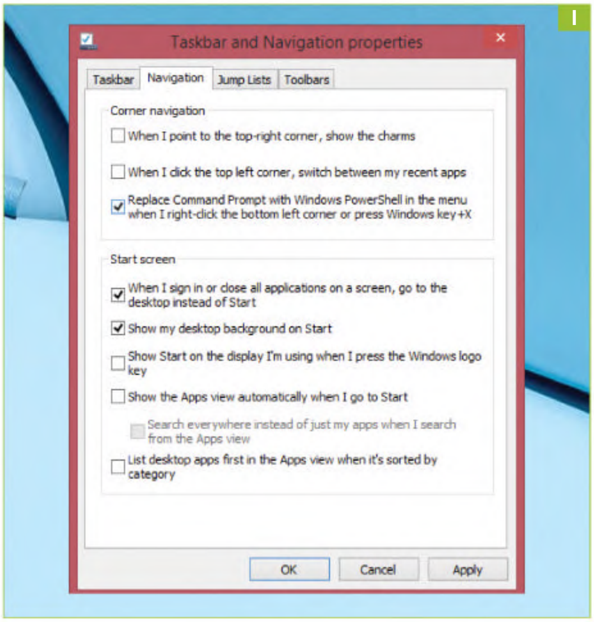
☑ Show the Apps view automatically when I go to Start

☑ Search everywhere instead of just my apps when I search from the Apps view

☑ List desktop apps first in the Apps view when it's sorted by category

5 SHOW ALL APPS

If you want to retain the Modern Start Screen but are keen to change the layout, it's possible to display all of your installed apps at once. Right-click on the Taskbar and choose "Properties → Navigation." Tick the last four boxes in the Taskbar and Navigation Properties dialog box (**Image H**). When you click on the Start button, you'll see all of your desktop applications first on the list.


I
Taskbar and Navigation properties
Taskbar
Navigation
Jump Lists
Toolbars
OK
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Apply

Corner navigation

☐ When I point to the top-right corner, show the charms

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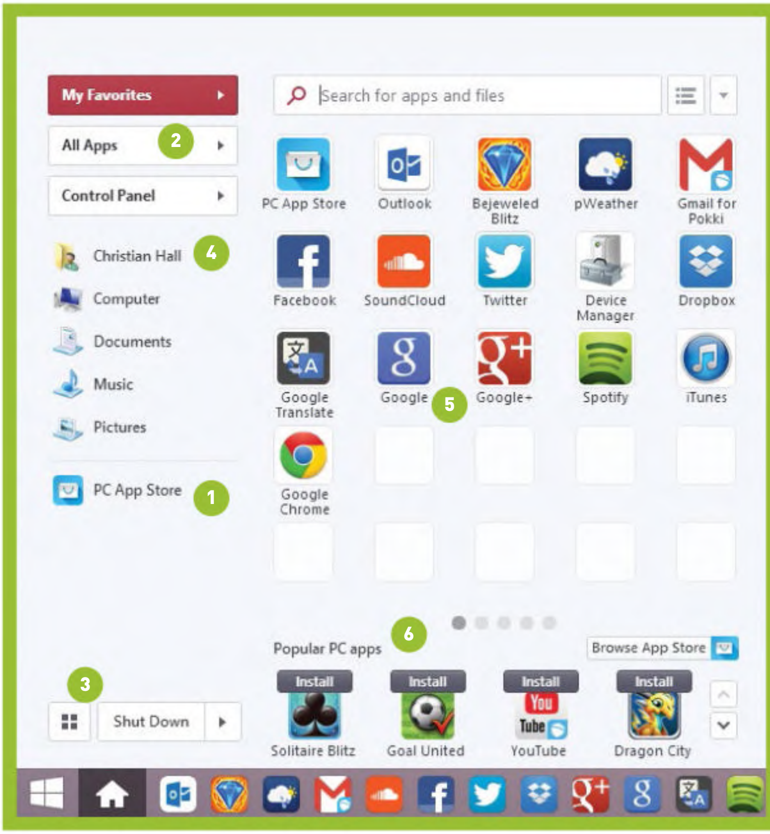
☐ List desktop apps first in the Apps view when it's sorted by category

6 REPLACE THE COMMAND PROMPT

Right-clicking on the Windows button brings up a list of power user commands. If you want to perform complex tasks that use DOS-style commands, you can replace Command Prompt with Windows PowerShell. To give this a try, again, right-click on the Taskbar and choose "Properties → Navigation" and tick "Replace Command Prompt with Windows PowerShell" (**Image I**).


My Favorites
All Apps
2
Control Panel
Christian Hall
4
Computer
Documents
Music
Pictures
PC App Store
1
3
Shut Down
Search for apps and files
PC App Store
Outlook
Bejeweled Blitz
pWeather
Gmail for Pokki
Facebook
SoundCloud
Twitter
Device Manager
Dropbox
Google Translate
Google
5
Google+
Spotify
iTunes
Google Chrome
Popular PC apps
6
Browse App Store
Install
Solitaire Blitz
Goal United
YouTube
Dragon City

POKKI POWER

1. PC APP STORE
Click here to install new Pokki apps through the store. Alternatively, you can use the search bar in the top-right of the Pokki menu.

2. ALL APPS
Gives you a list view of all your installed apps. Add them to your Favorites by clicking the star icon on the right.

3. TOGGLE START MENU
This button toggles between Pokki's Windows 8 Start menu and the Modern UI. Pokki's tool doesn't replace the Modern UI like some programs do.

4. YOUR FOLDERS
If you liked the way the traditional Start menu worked, with quick links to your folders, this is where they are in Pokki.

5. MY FAVORITES
Pokki groups your favorite apps like a smartphone home screen, making it faster to launch programs.

6. POPULAR PC APPS
Pokki's recommended apps appear here. These are an unpersonalized selection of popular installs.

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